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THE MAY SCIENTIFIC MONTHLY

Edited by

J. McKEEN CATTELL, F. R. MOULTON AND WARE CATTELL

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NEW BOOKS OF SCIENTIFIC INTEREST

Number. T. DANTZIG. Illustrated. x + 320 pp. Revised Edition. $3.00. Macmillan.

A book on mathematics dealing with symbol and form and with the ideas which are back of them. The appendix consists of 26 short articles concerned with historical information, philosophical questions and certain technical matters.

The Story of Astronomy. A. DRAPER and M. LOCKWOOD. Illustrated. xi + 394 pp. $3.00. Dial.

Against the historical background of the science, the authors write of astronomical tools, of the sun and the moon, the planets and the stars, comets and meteors, gaseous nebulae and galaxies, and of the universe itself.

The Decline of Mechanism in Modern Physics. A. D'ABRO. Illustrated. x + 982 pp. $10.00. Van Nostrand.

This book reviews the historical development of physical theories from their beginnings to the modern quantum theory. The book is divided into three parts: natural philosophy (in relation to physics); physical theories of the classical period; various quantum theories.

Bacterial Metabolism. M. STEPHENSON, Sc.D. Illustrated. xi + 391 pp. Revised Edition. $7.50. Longmans, Green and Co., Ltd.

The aim of this treatise has been to choose from the mass of data on the chemical activities of bacteria facts to gain an insight into the essential chemical processes accompanying the life of the organisms concerned.

Edible Wild Plants. O. P. MEDSGER. Illustrated. xv + 323 pp. $3.50. Macmillan.

A detailed description of 152 plants producing edible fruits, nuts, roots and leaves, together with informal bits of lore and legend. In each case the author tells how to prepare the food for eating.

A Biology of Familiar Things. G. L. BUSH, A. DICKIE and R. C. RUNKEL. Illustrated. 695 pp. $1.92. American Book.

A book on the biology of everyday life for high-school students. Emphasis has been placed on familiar forms. A wide variety of subjects are discussed, such as cultivation of flowers, care of pets, individual and community health, etc.

Strange Fish and Their Stories. A. H. VERRILL. Illustrated. xix + 220 pp. $2.50. Page.

The author has grouped his material according to the extraordinary habits or characteristics of fish, some of which are: fish that fly, fish that climb trees, fish with poisonous flesh, fish that walk on the ocean floor, fish with water pistols, etc.

The Boys' Book of Insects. E. W. TEALE. Illustrated. 237 pp. $2.00. Dutton.

This book introduces children to entomology, presenting facts about the lives and habits of the common insects together with simple instructions for collecting, rearing and studying them.

Ancient Andean Life. E. L. HEWETT. Illustrated. xix + 336 pp. $4.00. Bobbs-Merrill.

This is the last volume of a trilogy dealing with ancient American life; it attempts to present the American Indian in his proper place in the culture history of the world. This story is divided into three parts: "Human History of a World-Drama," "The Andean World," and "Retrospection and Conclusion."

Deserts. F. PICKWELL. Illustrated. xiv + 174 pp. Octavo. $3.50. Whittlesey House.

It is the goal of this book to show deserts, those that occur in California and Arizona as they really are; it illustrates the conspicuous animals and plants and striking scenery in sixty-four full page plates.

The Psychology of Making Life Interesting. W. WHITE. xv + 215 pp. $2.50. Macmillan.

This author suggests how a person may obtain variety for his own enjoyment. The book is divided into three parts: (1) dealing with people in life situations in general; (2) preventing unwholesome behavior due to tedium; (3) furthering mental health.

Civilization Against Cancer. C. C. LITTLE, Sc.D. vi + 150 pp. Farrar and Rinehart.

A statement of the whole cancer problem is presented for the lay reader by the managing director of the American Society for the Control of Cancer. Emphasis is placed upon the importance of early detection and treatment of the disease.

Elephants in Africa. F. MELLAND. Illustrated. xii + 186 pp. $3.75. Scribners.

A story of the life and behavior of elephants in Africa as observed by the author who has developed a real affection for these animals. He writes of their human characteristics, their charges and stampedes, their family life and domestication, etc.

A Book of Wild Flowers. M. MCKENNY and Illustrated by E. F. JOHNSTON. $2.00. Macmillan.

This book presents brief descriptive notes, and pictures, of a selection of some of the most widely distributed plants. The color pictures show the flowers in full bloom and the small black and white sketches the way they appear at the close of the floral season.

THE SCIENTIFIC MONTHLY

MAY, 1939

DRUG ADDICTION AS A PUBLIC HEALTH PROBLEM

By Dr. LAWRENCE KOLB

ASSISTANT SURGEON GENERAL, UNITED STATES PUBLIC HEALTH SERVICE

DRUG addiction is an engaging subject in the United States and a problem everywhere. Some countries pay less attention to it than we do, but all of them have more or less of it. It is a public health problem whose public health features have been obscured to some extent by laws designed to restrict the use of narcotics to medical purposes. The operation of these laws has in turn introduced other public health features having to do with the proper handling of persons who, in search of their favorite drug, are impelled to violate some law.

In a broad sense any drug that is regularly taken to produce unusual mental reactions rather than for a specific medical need is an addicting drug. There are many such drugs—some stimulating, some depressing and all harmful when used for non-medical purposes. The unusual reactions that these drugs produce are in the main pleasurable. By increasing physical and mental perception the stimulating drugs bring the addict into more intimate contact with the environment and give him an increased sense of power. By decreasing physical perception or the acuity of certain mental processes the depressing drugs enable the addict to escape from innate difficulties and disagreeable features or situations of the environment. The power to stimulate is not alone sufficient to make a drug attractive to addicts; there must be some distortion of function or sensation.

Strychnine is a powerful stimulant, but it has never been used for purposes of addiction. Cocaine, on the other hand, brings in an indefinite element that the addict is looking for, and it is the best example of a stimulating addicting drug. The depressive drugs act by producing mental and physical sedation or both. Some of the depressants, notably *cannabis indica* (marihuana), introduce an element of intoxication that is especially attractive to addicts, but may be, at least temporarily, terrifying. The sedative drugs, especially the hypnotics, may be merely stupefying. This is the reaction that many mentally distressed people seek, and with them it is a mild gesture towards complete oblivion in suicide. The stimulating drugs are more harmful, but the sedative drugs are more dangerous, because they are more attractive and more likely to cause addiction. Artificial stimulation eventually becomes unpleasant, but sedation is always pleasant; it is an answer to a universal human urge for peace and calm. We find, therefore, that the cocaine addict, becoming nervous, jumpy and apprehensive from increasing doses of cocaine, almost invariably changes over to opium when a prepara-

tion of this drug is available. He then discontinues cocaine or takes it only sporadically. Addiction to all drugs, including alcohol, has a natural tendency to gravitate toward some form of opium addiction. In an environment where different addicting drugs are equally accessible, many drunkards, marihuana addicts and cocaine addicts become opium addicts. Opium addiction is more attractive and more easily spread than addiction to any other drug. It is therefore more to be feared; and opium in its various forms is the drug that physicians and institutional, law-enforcement and health authorities usually have in mind when they speak of drug addiction.

Any preparation of opium that has pain-relieving properties will bring about physical addiction in any individual who takes it day after day. The time necessary to produce addiction depends upon the size and frequency of the dose and the method of administration. Smoking and eating opium are less dangerous forms of indulgence than the hypodermic or intravenous injection of morphine, heroin, dilaudid and other concentrated forms of the drug.

There are two reasons for the dangerous and seductive qualities of opium. First, it produces a sense of peace, calm and contentment without intoxication. Second, by its continued use the patient becomes tolerant to large doses, as well as dependent upon them for the maintenance of normal body functions and personal comfort. A certain degree of tolerance may be built up to increasing doses of many drugs, but opium is the only drug that produces dependence. A habitual user of morphine, the most important opium derivative, can in nine months build up tolerance from two quarter-grain doses per day to sixty grains per day, an amount sufficient to kill about fifteen unaddicted adults; but instead of being killed or seriously harmed by this large dose, the addict suffers intensely if he does not get it and may even die in collapse if the drug is abruptly taken from him. He becomes enslaved by his addiction, and it is this slavery that is so much feared. Both the stable and the unstable may become its victims. The physical slavery is the most spectacular thing about opium addiction, but it is not the most important thing with which the chronic relapsing addict has to contend. In a country like the United States, where opium can not be legally secured or prescribed except for medicinal purposes, the chronic addict is practically always an unstable individual, who is attracted to the drug by its soothing effect on his mind and his emotions.

The continued use of morphine brings about a certain amount of physical depletion; and this is especially marked if there is also regular or sporadic use of cocaine or some other narcotic. The deterioration in character produced in an individual by addiction results from several causes, such as the secrecy of the habit, the practice of evading issues and blotting them out with a narcotic instead of facing them openly, the parasitic life that so many addicts are compelled to live, the inevitable conflicts with the law, the undesirable social contacts that they must make in order to keep up the habit, the fact that so many of them must spend all their earnings to buy narcotics at exorbitant prices in the illegitimate market, and the physical harm resulting from alternating lethargy and physical and mental distress, due to too much narcotics one day and too little the next to maintain physical and mental comfort. Drug addiction is, therefore, a serious public health problem, as it undermines mental and physical health, forces users of narcotics into crime in order to keep up the habit which, for the time being, is vital to them, requires control measures to prevent spread, and imposes a burden upon the people as a result of criminal and other anti-social acts of addicts.

THE UNITED STATES PUBLIC HEALTH SERVICE HOSPITAL, LEXINGTON

Prevalence of Addiction

The drug habit is so strongly disapproved by society that an effort is always made to conceal it; and for this reason it has never been possible to secure an accurate census of the number of addicts in the United States. The Public Health Service made a careful survey of the situation in 1924 and concluded that in this country there were between 110,000 and 150,000 addicts to various forms of opium. Estimates made by the Bureau of Narcotics of the Treasury Department indicate that the number has decreased since that time, but marihuana addiction has lately come into the picture and is now being given serious attention by health authorities and law enforcement officers.

It was not until the latter part of the past century that the public conscience became aroused to the evils of drug addiction. Opiates were widely used by physicians for conditions for which they are not now prescribed, and until 1914 narcotics could be legally bought practically anywhere without a prescription. As a result, the incidence of addiction was much higher than it is to-day. Opium used for smoking was legally imported as late as 1909, and it is not unusual to find an addict to-day who started smoking in a legitimate opium den in order to find out first-hand what the effects might be. Before the advent of narcotic regulations, addiction among women was more prevalent than among men. The ratio from 1900 to 1915, when preparations containing opiates could be legally bought without a physician's prescription, was about two women to one man. It is now at least four men to one woman. Women, leading a more secluded and sedentary life and having fewer social outlets than men, unwittingly addicted themselves by self-medication for real or imaginary ills, the latter often based on introspection. But women are more law-abiding and they get into less tempting environments than men. As a result of these factors, addicted women were cured in great numbers and non-addicted women avoided illegal contacts after the passage of narcotic laws, while the men continued in spite of the law to satisfy their cravings and impulses to dissipation.

Addicts may be divided into nervously normal and nervously abnormal, or unstable individuals. The former were once quite common, but are now rare. The abnormal individual gets unusual sensations and pleasure from narcotics, especially opiates. He is normally in an emotional turmoil, with strivings and impulses that he does not understand. Morphine or heroin brings surcease from these emotional conflicts and disturbances for the time being and makes the afflicted indi-

vidual feel like a normal person. Becoming addicted and finding that the remedy was only temporary and illusive, he seeks cure, but relapses again because his emotional difficulties have not been corrected or properly interpreted to him. He does not understand why, but he goes back again to narcotics because he remembers the relief that they gave him previously.

The emotionally unstable individual who is so susceptible to addiction has impulses and strivings abnormal in kind or degree; he is reaching out for something that he does not understand and can not attain. As a result he feels restless, discontented and inferior. Morphine, by narcotizing certain functions, gives him a sense of ease, contentment and confidence. The contrast with his former self is so great that it is interpreted as pleasure. The subject formerly was afraid to attack his problems. He now knows that he could solve them, but the new-found ease and calm are so satisfactory that he feels there is no necessity to do anything about them. The solution is, however, only temporary. As the effect of the morphine wears off, he drops as far below his normal emotional plane as the drug buoyed him above it, and he must repeat and increase the doses in order to recapture the pleasing sensation that he had previously experienced. Thus he becomes a chronic relapser, and more than likely a parasite on his friends. He also often becomes a petty thief because, while physically addicted, satisfaction of the physical craving has become the most important thing in life for him.

The addict most to be pitied is the neurotic who has acquired physical addiction through having been given morphine for some chronic condition that is not completely curable but which does not call for continued use of the drug. More important, he becomes mentally addicted. He does not understand this, and rationalizes the continued use of the drug as necessary for his physical disease when, as a matter of fact, he uses it for the mental condition which it can never cure. Another large group of mildly unstable psychopathic individuals, who might otherwise be useful, take the drug for the same reason and thereby ruin their lives.

The opium habit is always harmful, but it is consistent with reasonable health and efficiency, and in the past many useful and even prominent people have been afflicted with it. Some chronic drunkards have accidentally lifted themselves out of the gutter by substituting the opium for the alcohol habit. The shift for them was from a greater to a lesser evil.

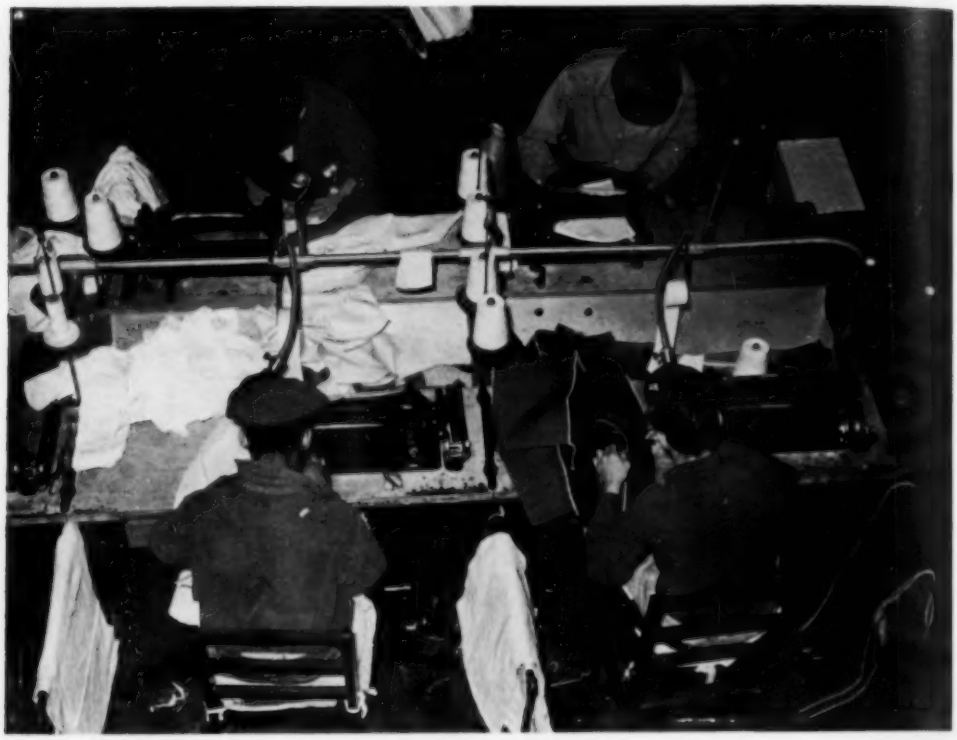
Tolerance to and the physical dependence upon opium together form one of the most interesting and baffling problems in medicine. The fundamental mechanism by which the body cells protect themselves from enormous doses of this drug, in such a way that when not bathed in it their functions may become so disturbed as to cause death, is not understood. There have been many theories to explain this phenomenon of tolerance and dependence, but none is adequate and all the treatments based upon them have been failures. The following are important among the theories that have been advanced: That the abstinence symptoms are due to a toxemia; that there is a rearrangement of the water molecule within the cell that protects it from morphine and causes a disturbance when the drug is withdrawn; that the lipoids of nervous tissue are dissolved by morphine, making the nerves more sensitive to stimuli; that morphine causes the development of immune bodies that protect the cells during addiction and poison them when the drug is withdrawn; that the withdrawal symptoms are a condition of anaphylactic shock

SECTION OF THE MAIN COURT OF THE HOSPITAL

A SOLARIUM AND WALKWAY FOR TUBERCULAR AND OTHER PHYSICALLY ILL PATIENTS IS SHOWN ABOVE UPPER STORY ON THE RIGHT.

produced by the union of an antigen and anti-bodies which, in the absence of morphine, unite and produce shock; that the drug normally combines with a sensitive cell receptor, producing euphoria, but stimulating the formation of additional receptors that, in the absence of morphine, are combined with by a stimulating hormone, with consequent overstimulation and the withdrawal symptoms that there is disturbance in the water balance during addiction and withdrawal; and other less important theories. In addition to the treatments based upon these theories, there have been numerous empirical treatments for which much has been claimed. It is unlikely, however, that any specific treatment for the withdrawal symptoms or morphine addiction will be discovered until the mechanism of physical addiction is adequately explained.

The preventive measures for the control of addiction consist largely of laws and regulations designed to restrict the use of narcotics to medicinal and scientific purposes. These laws are adequate and effective in so far as repressive measures are concerned. They have resulted in protecting people from addiction and in causing numbers of addicts to seek cure; but they are not the complete answer to the problem. Physicians are now very careful in prescribing narcotics; but they sometimes necessarily or unwittingly introduce unstable people to morphine, who thereafter seek the drug in spite of warnings. In order to reduce the danger of prescribing the narcotic drugs, the American Medical Association has published a series of papers on "The Indispensable Use of Narcotics," which are designed to orient physicians so that they limit the use of these drugs as far as possible. For the same purpose the United States Public Health Service is cooperating with other groups in a study to determine the amount of morphine or co-



THE TAILOR SHOP

ALL CLOTHING USED BY THE PATIENTS, INCLUDING GOING-OUT SUITS AND OVERCOATS, IS MADE HERE.

deine sufficient to control cough. These studies indicate that codeine, which is less addicting than morphine, controls cough as much as drugs may be expected to control it and that much smaller doses than were formerly used give good results. Many tuberculous patients have been addicted to morphine through having it prescribed for cough, and studies at the Lexington hospital show that these patients, if not in an advanced stage of the disease, gain weight and do much better generally when morphine is withdrawn.

The treatment of drug addicts has become a serious public health matter, and it is complicated by the enforcement of laws necessary to control the distribution of narcotics. The most important of these laws, the Harrison Narcotic Act, has been effective in controlling the manufacture and sale of narcotics in legitimate trade, but it made no provision for the medicinal treatment of addicts who violated the law. Thousands of these were at first sent to prison, where their real needs were neglected. They were treated there as prisoners deserving punishment rather than as patients who needed treatment. As a rule, they easily recovered from their physical addiction, but their emotional attitude toward the situation was made worse by the sense of injustice that had been done them and by the general harshness and barrenness of the prison environment. The result was, too often, prompt relapse on discharge, with a vicious circle of other violations and prison confinements that continued the ruin started by narcotics.

The injustice and futility of this method of handling addicts became more

and more apparent, and in 1929 the serious defect in the original law was corrected by the passage of an act establishing two narcotic farms, now known as United States Public Health Service Hospitals. One of these hospitals is located at Lexington, Kentucky, and the other at Fort Worth, Texas. The purpose of these institutions is to study and disseminate information about drug addiction and to rehabilitate and teach to be self-supporting and self-reliant addicts who are admitted to them. A convicted federal addict offender may now be sent to one of these hospitals instead of to prison; but, more important still, the court is empowered to place such offenders on probation, a condition of the probation being that they enter one of these hospitals for treatment and stay until cured. By this measure the addict is saved from the stigma of a penitentiary sentence and is given treatment under a mild form of restraint, which he usually needs. These hospitals are also authorized to treat voluntary patients. This is important, because the average addict is not financially able to secure treatment in sanitariums, and the general hospitals that accept such patients only irritate them by a short period of treatment that, as a rule, leaves them worse than they were before they entered. Often repeated fruitless treatments, with immediate relapse, are more harmful to the physical well-being of addicts than no treatment at all. Successful treatment involves two important procedures—cure of the physical need for the drug and cure of the mental condition that makes it so attractive.

The narcotic hospitals holds the convicted addict as a prisoner, but treat him as a patient. The hospitals' approach to

TESTING EMOTIONAL RESPONSE OF SUBJECT TO PSYCHOLOGICAL STIMULI
UNDER NORMAL CONDITIONS AND UNDER THE INFLUENCE OF MORPHINE, ON THE BEHAVIOR PHOTOPOLYGRAPH IN THE PSYCHOLOGICAL LABORATORY OF THE LEXINGTON HOSPITAL.

the treatment problem is based on the assumption that, while physical addiction is a very important thing that must be cured, the psychological angles of the case are much more important, and on the belief that if the patient is to achieve permanent cure he must be relieved of his emotional difficulties or taught to adjust to them without resort to narcotics. The aim is to give the patient a new outlook on life and to build up a new set of habit patterns so that he can resist the impact of former associations and temptation when it is not possible to avoid them. The first step in the mental readjustment of the patient is the treatment of the physical withdrawal symptoms. By neglect or an unsympathetic approach during this phase of the treatment, mental scars may be made that are difficult to remove. The withdrawal period is a difficult one for the patient. If his habit is strong, he suffers intensely, and if not properly treated he may collapse and die. Restlessness, tremors, muscular twitchings, insomnia, nausea, vomiting, pains and feelings of weakness, nervousness and insecurity cause many to fear death. An added mental depression leads others to attempt suicide. These symptoms should not be made light of and ignored. Addicts under treatment practically always ask for morphine, and practically always safely get over the withdrawal period regardless of whether or not they are given morphine or any other kind of treatment. For this reason they are thought by some to simulate the symptoms or grossly exaggerate them. That the symptoms are real is shown by the fact that morphine addicted animals, especially monkeys and dogs, suffer with them. The author injected increasing doses of morphine into a number of monkeys twice daily for nine months, and then abruptly discontinued it. One animal died, several others developed serious symptoms of collapse, but recovered, and all of them showed unmistakable signs of physical depression and suffering.

Unfortunately, some addicts have been killed by unscientific treatment or by neglect and indifference, based on the conception that addicts are criminals who should be allowed to suffer. It has even been regarded as a sort of sin to give morphine to an addict in withdrawal, and the author knows of several instances in which addicts died as a result of treatment based on this falsely pious attitude.

At the narcotic hospitals all types of specific withdrawal treatments have been discarded as harmful or useless. An effort is made to gain the confidence of the patient by approaching his problem with a sympathetic attitude. The morphine is then rapidly withdrawn and supportive measures are employed that are designed to reduce the severity of the symptoms and avoid collapse. By these methods the worst of the withdrawal symptoms are relieved in from ten days to two weeks, and a start has been made on the psychological readjustment. Time is an important element in treatment. Some, mostly accidental medical addicts, have been permanently cured in a few weeks; but cure of the unstable patient in such a short time is not to be expected. Work done in the research laboratory at Lexington shows that some of the physical functions, disordered by the long-continued use of morphine, do not return to normal for months after the drug has been discontinued. During this period the patient is naturally more susceptible to relapse for physical reasons.

Time is more important for the successful treatment of the mental habit than for that of the physical addiction. The addict, even if he has sufficient narcotics, becomes uncomfortable several times a day when the last dose wears down. If another dose is not available, he suffers acute distress in about eighteen hours. Over a period of years he relieves such

discomfort or distress thousands of times by injections of morphine. During this same period he enjoys the drug in pleasurable associations with friends and by taking it to get the effect that many of them describe by the statement "It makes my troubles roll off my mind." By thus building up a strong association between pleasure and pain and the taking of a narcotic he becomes conditioned to taking one in response to most any situation that may arise. It may be because of some minor physical discomfort or because he meets a friend or feels so happy over being cured. By being compelled for months to adjust to all situations without narcotics he becomes unconditioned, so that he is able to give at least intelligent resistance to narcotic suggestions. In addition to this unconditioning, and as a substitute for old habits, new habits must be built up; and for this reason the addict under treatment should be kept busy in some useful way during all his waking hours. At the narcotic hospitals this is done through the means of work on the farm and in shops and by reading and recreation. Some patients are benefited by intensive psychotherapy that is designed to give them a better understanding of themselves and their weaknesses, and all of them receive at least a minimum amount of psychotherapy. By these means new habit patterns are built up, a new outlook on life is formed, the patient is made better to understand himself, and he goes out prepared to face and fight his problems rather than to evade them by the use of narcotics. It is important, too, that he should leave without resentment, feeling that he has not been punished unnecessarily, but that an effort has been made to do something for him. The effort often fails. The strength of the habit and the human material from which addicts are recruited makes this inevitable, but permanent cure has been achieved in a large proportion of cases. The importance of resentment as a barrier to cure is shown by prisoners who, complaining of the injustice of their confinement for four years, promptly relapse on being discharged and then return as voluntary patients and cooperate in the treatment.

OUTSIDE THE METABOLISM CHAMBER

THE PHYSICIAN IS TELEPHONING TO PATIENT WHILE OBSERVING HIM THROUGH THE CHAMBER WINDOW. IT IS AN ABSOLUTELY AIR-TIGHT CHAMBER IN WHICH THE PATIENT IS KEPT FOR TWENTY-FOUR HOURS. ALL FOOD, WATER AND AIR THAT HE TAKES IN AND ALL EXCRETIONS, INCLUDING PERSPIRATION AND EXPIRED AIR, ARE MINUTELY MEASURED. COMPARISONS ARE MADE ON THE SAME SUBJECT DURING AND AFTER ADDICTION TO MORPHINE. EVERY MOTION OF THE PATIENT IS RECORDED ON A MOVING DRUM.

Addiction to marihuana and cocaine have the same psychological implications in so far as etiology is concerned as addiction to opium. Addiction to these drugs is much more likely to lead to positive criminal acts, based on stimulation and bizarre mental reactions. Addiction to them is, therefore, more of a police problem than is addiction to opium. The latter brings about only negative crimes, motivated by physical necessity. The treatment of addiction to the other drugs is, however, the same as the treatment of addiction to opium, minus the necessity for special attention to physical dependence.

Everything possible in the way of narcotic regulation is being done to prevent people from becoming addicts, and much is being done towards improving the lot of addicts themselves, but much more needs to be done. It is important that the public be informed as to the exact importance of drug addiction in its relation to other things, so that the addict may be regarded not necessarily as a criminal, but as a sick person, who needs more attention from the physician and less from the police. Drug addiction should be treated as one phase of a general program for improving the mental and physical health of the people. More treatment facilities are needed, especially for women. It is a reflection on our society and our government that some addicts, unable to get treatment elsewhere, ask to be sent to prison for a cure. When the addict leaves the hospital or prison, he should be given an equal chance with others to secure work, as enforced idleness and unfounded suspicion directed toward him are among the most potent causes for relapse.

A long-time research into the fundamental nature of opium addiction is desirable. A start has been made on this at the laboratory of the Public Health Service hospital at Lexington, where metabolic, biochemical, electroencephalographic, psychological and other studies are being carried on. There is also in progress a research designed to develop a drug that has the pain-relieving properties of morphine, minus its addicting qualities. This investigation is being conducted by the Public Health Service in cooperation with the Committee on Drug Addiction of the National Research Council and other agencies. The goal of these various measures is to prevent and to cure addiction, just as the goal of other public health activities is to prevent and cure other physical and mental ills that beset mankind.

UP MOUNT KINABALU

I. White Man and Natives Begin Ascent

By JOHN A. GRISWOLD, JR.

RESEARCH ASSISTANT, MUSEUM OF COMPARATIVE ZOOLOGY, HARVARD UNIVERSITY;
MEMBER OF THE ASIATIC PRIMATE EXPEDITION.[1]

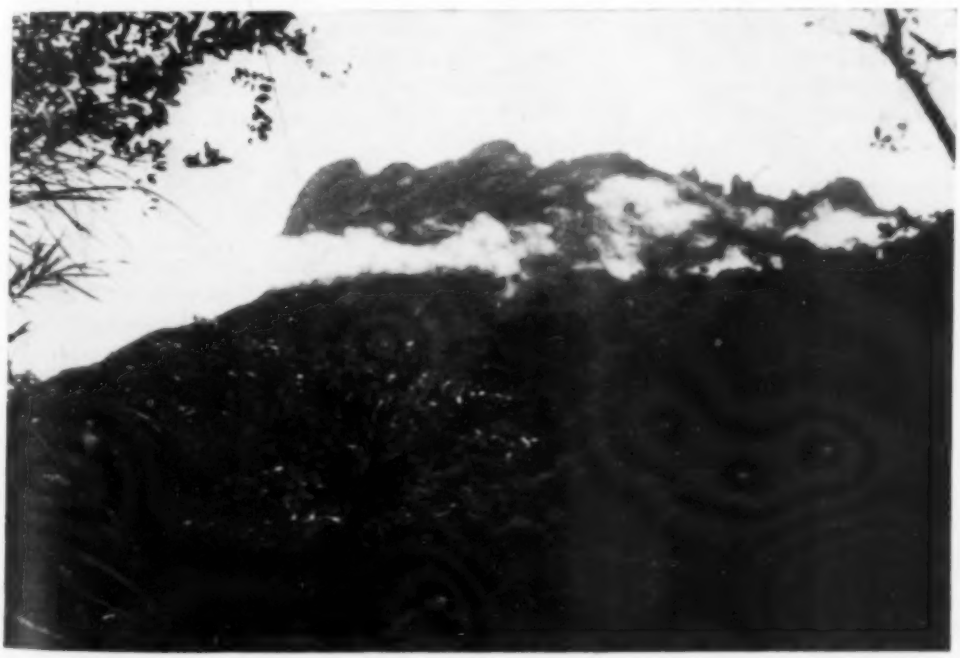
Mt. Kinabalu in British North Borneo is the highest mountain in Malaysia, its loftiest peak, Low's by name, reaching a height of 13,455 feet. There is no other physical feature in the whole of North Borneo that is so striking or so awe-inspiring, both to whites and natives alike. To the zoologist, especially the ornithologist, it is of the greatest interest.

Kinabalu stands twenty-five miles from the coast, and can be seen a hundred miles out to sea. The mountain itself consists of a system of ridges, the exact relationships of which have never been worked out. Therefore, it is hard to say exactly when one really starts climbing the granite mountain which is inaccessible on all but the north side.

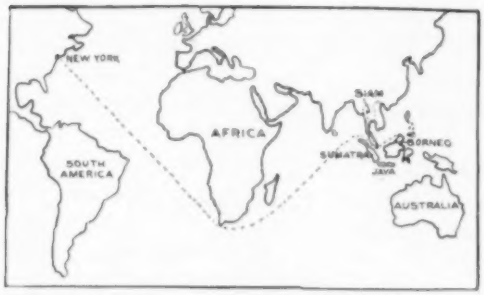
The mountain was first climbed by Hugh Low in 1851 and since then by many visitors. The majority of these travelers were naturalists, and to the credit of one of them, John Whitehead, are over sixty new species of birds besides many mammals. It was for this reason and its accessibility that it was decided I should collect there.

On my arrival in Jesselton I at once

[1] This cooperative expedition organized by Harold J. Coolidge, Jr. of the Harvard Museum of Comparative Zoology made documented collections of primate material, behavior studies on wild primates (especially the gibbon), and general zoological collections in the mountains of Northern Siam and in British North Borneo.



MOUNT KINABALU



THE AUTHOR'S ROUTE TO BORNEO

paid a call on the Resident, Mr. Evans, who, already having been notified of my intentions, had engaged a cook for me. It was mainly through his assistance that my trip was made possible and the burden of the journey made easier. He gave me valuable information, engaged the services of an interpreter and arranged porters for the first day of the five-day trip inland, in addition to procuring "bonguns," the native basket that is ideal for carrying one's supplies.

Mr. Evans also introduced me to George Moffatt, head of the Government Audit Office, who was of the greatest help to me while I was on the mountain. It was he who forwarded my mail and the extra supplies I needed by a system of weekly mail runners.

The week I spent in Jesselton was a hectic one, what with sorting equipment, purchasing food, blankets and other necessary articles, as well as interviewing prospective camp coolies and a man to help me with the skinning.

DUSUN PORTER

WITH A BONGUN ON HIS BACK, AND CHINESE SKINNER SHIM TIAM FOOK JUST BEYOND HIM.

My final retinue was as follows: Mohamed Ali, interpreter; Andu Majanon, cook; Magunjang, camp coolie; and Shim Tiam Fook, skinner. Shim Tiam Fook had never skinned a bird in his life and only one monkey that I shot to try him out. He was so conscientious and did so well that I decided to take him on. He subsequently became an excellent skinner and proved the wisdom of my judgment. He was a thoroughly nice chap, hard-working, polite and with a good deal of authority over the natives.

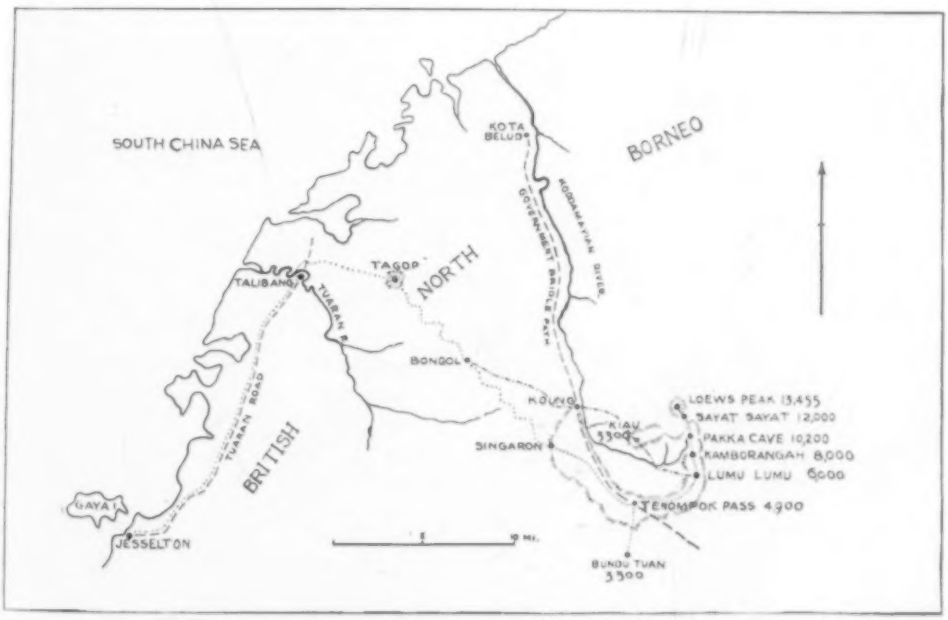
I had decided to make our first collecting camp at Lumu Lumu at an altitude of 5,500 feet, which is the next to last stopping point before the summit is reached.

The morning of May 31st was set for our departure. The day before I had arranged for two buses to call for us at the Government Rest House at 6 A. M. At 9:30 we arrived at Talibong, where I was met by the local chief, thirty-four porters and a Government policeman. After an hour and a half of general scramble by the porters for the lightest and most convenient loads to carry and then a search for bark to make carrying straps and to tie the loads, we finally got started.

I had learned from previous experience that the quickest and most efficient system is to make up the loads yourself so that they all weigh approximately the same, and then let the porters decide amongst themselves what each is to carry. It then becomes only a question of keeping a weather eye open to see that nobody lightens his load by hiding a box or tin behind a tree, to be discovered when you are all ready to start, because there will follow a heated argument when you try to add it to the load of one of the porters.

MAP OF THE EAST INDIES

SHOWING MOUNT KINABALU AND ROUTE FOLLOWED.



DETAIL MAP OF MOUNT KINABALU,

TO SHOW ROUTES TAKEN BY THE AUTHOR. . . . . INGOING ROUTE; -.-.-.- OUTGOING ROUTE.

MODIFIED FROM F.M.S. SURVEY NO. 149. 1932.

THE LARGE GOVERNMENT RESTHOUSE AT BUNDUTUAN

BUNDUTUAN VILLAGE AS SEEN FROM THE RESTHOUSE

Crossing the Tuaran River, we left the road for a narrow trail along its left bank through cultivated land and bamboo groves. Fifteen minutes later we stopped to let the stragglers catch up and the men adjust their loads. Since this was also the last place the porters could obtain water before reaching our destination, many of them cut sections of bamboo which they filled with water and strapped them to their loads. It was an hour before the last porter caught up with us, his load falling apart. Some of the more experienced carriers set about adjusting his burden, while the others jeered at the poor fellow.

At last we got started and made good progress for about two hours, when again we were further delayed by the same man's lagging behind. This time, however, the cause was much more serious. I found that only recently he had recovered from an attack of beriberi, and that he had not regained his strength sufficiently for such strenuous work. He staggered along the trail at a very slow pace and whenever he came to a log across the path it was all he could do to step over it, his skinny legs quivering like a branch that is caught in a rushing stream. I lightened his load considerably, but even then he seemed so exhausted that I finally had my camp coolie carry his load.

At one of our many halts beside a small river my pet monkey "Minnie," that I had brought from Siam, surprised me by voluntarily going swimming. She would jump from the four-foot bank into the deep water, completely submerging and then swim against the current to the shore. This act she repeated several times, apparently enjoying it immensely.

MOUNT KINABALU FROM 3,300 FEET, AND COOK ANDU

At five o'clock, after a steep climb in the rain, we arrived at the kompong, or village, of Tegop, perched on the side of a hill. We passed through the village to its outskirts, where we found the Government Rest House, a small bamboo structure with a palm-leaf roof, all raised some four feet off the ground. From here we had a wonderful view of the village with its beautiful green grass, its coconut palms and native huts. Far be-

LAW ENFORCEMENT
A NATIVE POLICEMAN AND GOVERNMENT DRESSER.

TENOMPOK PASS,
4,900 FEET. CAMP COOLIE MAGUNJANG, WITH MINNIE ON HIS SHOULDER.

low the valley stretched down towards the ocean, which was just visible through the clouds and haze.

Early next morning I relieved three of my porters on account of sickness and injuries incurred on the way. Each man was paid $.35 Bornean currency for his day's work, which is equivalent in purchasing power to $18 in America. We left Tegop at 7 A. M. for Bongol, four porters and I arriving there in the early afternoon. The Rest House was situated near a small stream in an open field. At 4:30 most of the porters and my men reached the river, having missed their way. They had to cross it before climbing the bank to the Rest House, but what had been a shallow and gently flowing stream was now a deep and rushing torrent. After repeated attempts, Ali, my interpreter, swam across with a large vine attached to his belt. With this vine as a starter, we were able to construct a temporary bridge and get the porters over safely.

Early the following morning I went down to the now subsided river to take a bath. It was not yet light, but I could see the vague outlines of nightjars as they coursed up and down stream, passing a few feet above my head. As I returned to the Rest House the day suddenly broke and there, appearing so near but yet so far away, towered Kinabalu, majestic and almost terrifying in the early morning light. It was not hard to see why the natives held it in such veneration and considered it to be the resting place of their souls after death, and only to be visited by those who took with them a priest to perform adequate sacrifices and prayers.

At seven o'clock the new porters straggled in, eight of whom were girls and old women. One man wore only a loin cloth and a bark shirt, which was ideal for such hot work as carrying. This day's trip to Singaron was made miser-

DUSUN PORTERS AT TENOMPOK PASS, ELEVATION 4,900 FEET

able by continual rain all the afternoon, for the steep trails turned into rushing streams and the path was very slippery. By the time we arrived there I was covered from head to foot with mud and my pith helmet had several dents in it, as did my cigarette case, which I had put under my helmet to keep it dry.

The Singaron Rest House was more or less like the first one, but its roof leaked

A CROWD OF NATIVES AT TENOMPOK MARKET

BUYING AND SELLING AT THE TENOMPOK MARKET

badly. So I sent for the local chief, who had it patched with banana leaves by his two naked and dirty sons. I also asked him for ten porters for the following morning, because all the women wished to return to Bongol. Towards evening I toured the kompong and bought eggs for 1 cent apiece, four bananas for one cent, two chickens for thirty cents, as well as tapioca and potatoes at corresponding prices.

Next day my interpreter and I, with a guide, made a quick march to Kiau, a large village of over three hundred people, where I could secure the necessary porters, priest and guide for climbing the mysterious mountain. My staff with the rest of the porters were to proceed to Tenompok, where we would spend the night.

I was under the impression that Tinompok was a village, but subsequently discovered it to be only a pass at 4,900 feet, which the Government Bridle Path crosses. The Bridle Path runs from Kotabelud, a large town on the seacoast in the interior. It not only affords government officials a quick and easy means

of entering the interior but enables the natives to get their products down to the coast for sale, chief of which are rice and tobacco.

The trail to Kiau and from there to Tenompok was much longer than I expected it to be and was one of the most difficult and arduous walks I have ever taken, being steep downhill grades and still steeper and longer uphill grades. It is because of this roller-coaster-like country that it takes so long to cover a short distance. A mile as the crow flies is at least six miles by trail.

MACAQUE MONKEYS AT LUMU LUMU
MINNIE HAS BABY PISANG IN HER ARMS; KINA IS AT THE RIGHT.

In the valley below Kiau we crossed the Kadamaian River by a seventy-foot span bridge of bamboo. We then toiled up the last, longest and steepest hill in the heat of the midday sun. At Kiau I met Derensai, the high priest, with whom I had a long talk about ascending the mountain, expenses for sacrifices and guide and porter fees. I also arranged to have him send thirty-seven porters to go up to Lumu Lumu, as well as two extra men to act as mail messengers to Jesselton.

HOMEWARD BOUND

At Kiau I visited one of the long houses where about ten families live together. In this long house I saw an old "parang," or native sword, that the natives once used for cutting off the heads of their neighbors, when they went on head-hunting expeditions. Ten minu-

NATIVE HUNTER WITH HIS BLOWPIPE

tes' dickering and I had bought it for five Borneo dollars.

Leaving Kiau we again descended the steep hill to the Kadamaian River, where we came across a group of men and women wailing in the most dismal tones. Our guide was terrified and ran down to the river and crossed another bamboo bridge. When we finally caught up with him he told us that one of the people in this mournful procession had dysentery and that the victim was being escorted to the river in order to wash the bad spirits away. At this moment, the group appearing on the opposite bank, our guide fled up the narrow trail, still fearing that the evil spirits would bewitch him, while Ali and I remained to see the priest make a sacrifice and the sick man cleanse himself in the rushing water. This was a perfect example of the way dysentery is spread and an obvious reason for boiling all drinking water.

Along the trail we saw several groups of macaque monkeys (*Macaca irus*), and at Tenompok pass I was thrilled by my first glimpse of an iridescent green bird that flew swiftly over our heads. This was Whitehead's broadbill (*Calyptomena whiteheadi*), which is indigenous to the tall, damp forests of Kinabalu between the altitudes of 4,000 and 5,000 feet.

The Bundutuan Rest House, where we were destined to spend the next three days, was almost palatial. It was very large, with two separate bedrooms and another large room with a stone fireplace. The floor was of roughly hewn

MY CAMP AT LUMU LUMU, 5,500 FEET

"A COLDER AND DAMPER AND MORE MISERABLE PLACE I HAVE NEVER BEEN IN."

LIKE SO MANY MEDIEVAL TOWERS, 12,500 FEET

boards, the sides of bark and the roof of leaves sewn to sticks six feet long, which were overlapped to form shingles. The house was of course raised some feet from the ground. An adjoining house served as a kitchen, where running water was supplied by long pieces of bamboo to form a miniature aqueduct. The entire place was surrounded by a corral, with a stable at one corner. Rest houses of this magnitude are found on every day's journey along the Bridle Path.

It was here that my guide, Labuan, joined us. Although he was only a boy in his teens, frail-looking and quiet, all the natives respected and obeyed him. He had guided many parties up the mountain and was, in fact, the only one who knew the trails well.

Labuan informed me that unless I had tents it would be impossible to have a waterproof shelter at Lumu Lumu, for there was nothing with which to make a roof. This was indeed disconcerting news, for I only had one small tent and one tent fly. The only solution appeared to be to gather "Kabu" leaves and carry them up to Lumu Lumu. We bought the 2,000 which would be required for the equivalent of one American dollar.

The following day the porters carried up some of our loads, as well as the leaves, to the camp site at Lumu Lumu. They were to spend two days in building a shelter and then return to carry up the remainder of our equipment. During this time I did active collecting. The Dusun villagers soon discovering what I had come for, numerous children constantly arrived with beetles, grasshoppers and lizards ingeniously strung on pieces of rattan which, with bamboo, is so valuable to these people. In fact, given these two materials and a knife, a Dusun can make almost anything.

The Dusuns are indigenous to Borneo and one of the most predominant races. "Dusun" is a Malay word meaning "orchard or village or collection of houses." The name has now been loosely applied

CLOSE-UP OF CAMP AT LUMU LUMU
SKINNER AH FOOK ON THE LEFT, AND INTERPRETER CHANG AH TET ON THE RIGHT.

to this group of people. They are animists, worshipping and fearing the more or less hostile spirits of mountains, rocks, trees and their ancestors. They are very superstitious, having great faith in omens like the call of the woodpeckers. Although the Dusuns are administered under the Indian Penal Code, matters of marriage, debts, inheritance and divorces are wisely left to their own laws. They usually have one wife, and divorces are not infrequent.

END VIEW OF CAMP AT LUMU LUMU

The villages are usually beautiful places, with attractive bamboo houses, tall and stately palm trees and lawns of the greenest grass, kept like a tennis court by grazing buffaloes. The houses, whatever their size, are all built on the same principle. The largest one I visited, sheltering more than forty persons of different families, was about 120 feet long, with floor of bamboo and roof of palm leaves. The entrance to the floor, about five feet above the ground, was at one end and reached by a sort of narrow gangplank. There were no windows, but there were slits cut in the wall at frequent intervals.

One side of the house is partitioned off into private sleeping and cooking quarters, in the form of cubicles, for each family. The other side is a vast common room. The house was comparatively clean and the floor was polished by the bare feet of its occupants, whose daily life is epitomized by the large collection of their various belongings, scattered about everywhere. Large glazed jars, arranged along one side, contained rice and rice toddy. Baskets, hats, traps and other numerous bamboo and rattan articles were piled in corners, hung on pegs or stored in a sort of attic. Underneath the house pigs grunted, chickens scratched and mangy dogs lolled, while beehives hung from under the eaves.

The wealth of a Dusun family is not judged by the number of pigs or buffaloes, but by the number and quality of its gongs. An "A–I" gong is known as a "China Kimanis" and might be worth as much as 200 to 700 American dollars. Some years ago, when one of these gongs was confiscated and auctioned, it was bought in for $2,500 United States currency. The proceeds from the sale of tobacco are saved for many years in order to buy a gong.

The Dusuns are short, sturdy, cheerful, not over-clean people, but exceptionally

ONE OF THE PEAKS OVERLOOKING LOW'S ABYSS

honest. They are, however, too shrewd and argumentative in bargaining. They were also most reliable and well-disciplined carriers, and once they get to know you and find out that you stand for no nonsense, everything goes well.

The Dusun women are small and well built and would be really quite pretty if they did not chew betel-nut, which blackens their teeth. The color of their skin is like that of a white person with a good sun tan, and their black hair is brushed smoothly back from their foreheads, ending in a topknot enclosed in a hairnet. Their dress, a long dark blue skirt almost reaching to their ankles, is held up by a series of brass rings or belts of five-cent pieces, which sometimes weigh in the neighborhood of ten pounds. A young girl or newly married woman will wear a piece of cloth over her breasts, held in place by hoops of lacquered rattan, leaving the whole back bare. Dusun women who have had a child usually wear nothing but the skirt. By contrast, the men are less picturesque, either wearing nothing but a loin cloth or an odd assortment of European clothes and a turban.

On the evening of the third day of our stay at Lumu Lumu the men returned from the mountain, saying that by working hard they had managed to complete the house. A few of them also brought one ground shrew, a tupaia and a spiny rat, all of which were in various degrees of decomposition, but knowing they were indigenous to the mountain and not knowing when I might get another, I skinned and made them up. It was at this point that I learned that my skinner had such an aversion to rats, verging on real fear, that for the rest of the trip I was to make up anything that had a ratty-looking tail.

The following morning we packed up for the last leg of the trip. Some of the loads being too light and learning that there was no bamboo at Lumu Lumu, I added lengths of this valuable material to the lightest loads but not without a great deal of arguing.

At Tinompok we branched off on to a very narrow and newly cut trail leading to the left at right angles to the main path. Three hours along this trail, which my porter had cut, brought us to our camp site. In spite of the steep ascent and the cold and dampness of the early morning, I was in high spirits.

The forest was tall, thick, very quiet and gloomy. Slippery logs and matted roots impeded our progress and a heavy mist clung to the very ground. There was hardly a tree or rock that wasn't covered with moss, and in certain places it formed a soft and squishy carpet, perforated with numerous rodent holes and trails. It wasn't until later that I learned that "Lumu Lumu" in Dusun meant "Mossy Mossy." No more appropriate name could have been chosen. Moss was the one thing that was everywhere, and in that respect reminded me of my camp on the top of "Doi Angka," in Siam.

(To be concluded)

LITTLE-KNOWN FOSSILS

By Dr. CHARLES T. BERRY

THE JOHNS HOPKINS UNIVERSITY

EVERY one who has ever lived along the seacoast is familiar with the common five- or six-armed starfish which is found clinging to the sides and bottoms of rocks just below low tide. These animals usually form one of the treasures in a small boy's collection, if he has ever gone wading in the ocean. Besides being of interest to the layman, these animals are of great economic importance, for they feed upon oysters among other things and are the greatest pest with which the oysterman has to contend, oftentimes destroying his entire bed and thus his livlihood.

Along with these destructive animals there can be found under the same rocks—if one's eyes are sharp—small five-rayed, slender serpentine-like armed animals, which are the first cousins of the starfish. These are called by some people serpent or brittle stars, but to the scientists they are known as Ophiurans. These brittle stars are seldom seen by the average person, for they leave their hiding places, under the rocks, only at night to go in search of food. Their search does not lead them to destroy things of economic value, so consequently they never make the headlines.

Both types of these animals roam the seas by the thousands and have done so for countless centuries. The brittle stars are descended from the starfish, whose line goes far back into Cambrian time some 540,000,000 years ago, when life first appeared on the earth. Associated with these primitive starfish, but much more numerous, were animals like the well-known trilobites and shellfish similar to our present-day oysters and clams. If the average person were shown one of the early primitive starfish he would undoubtedly object to its being called such; for instead of its having long flexible arms and measuring several inches across, it was less than half an inch in diameter, with very short, rigid arms. Heavy thick plates covered it, so that it was encased in a coat of armor. Unlike the plates of many of the living forms these did not possess any spines. After this primitive starfish various stages have been found which show the evolution of the animal. This evolutional trend is best illustrated by the arms, which became more and more flexible. This was accomplished by the dividing up of the heavy plates, thus decreasing their size; new plates were added, while others were undoubtedly reabsorbed. Thus with more and smaller plates the body and arms became more flexible, the latter lengthening until the present type of animal appeared.

The history of these animals as one traces it through the past is very interesting, for apparently they did not evolve gradually from a very few types into many different kinds until their present great number were reached. Instead, very few appeared at first here and there, and then as time went on they slowly increased. Suddenly conditions in the sea changed and the starfish found themselves in an unsatisfactory environment which forced many of them out of existence, leaving only the more sturdy ones to carry on the line. Again at another period (Fig. 1) prosperity would return and their population would increase rapidly only to decrease in the following period. The starfish reached their maximum extent, geologically

FIG. 1. DEVONIAN STARFISH. ×1.

speaking, during the Cretaceous period, when about sixty-five different types swarmed the seas.

During this time they had such companions as large turtles and fishes and serpent-like reptiles, which inhabited the seas together with many of present-day oysters and clams. Could the starfish have looked upon the land he might have watched the decline of the dinosaurs, and seen the forefathers of our mammals just starting to occupy the world, and he could have been a spectator as well at the formation of the early Rocky Mountains. With the close of this era conditions changed to such an extent that the starfish were almost completely destroyed, fewer surviving then than at any previous decline in their history. The few types which survived the Cretaceous continued to dwindle until at the close of our recent Ice Age there were only six types in our seas. With the melting of the ice in the northern hemisphere the oceans apparently changed to the liking of the starfish, for to-day they are found scattered throughout the world, there being something like 750 different types.

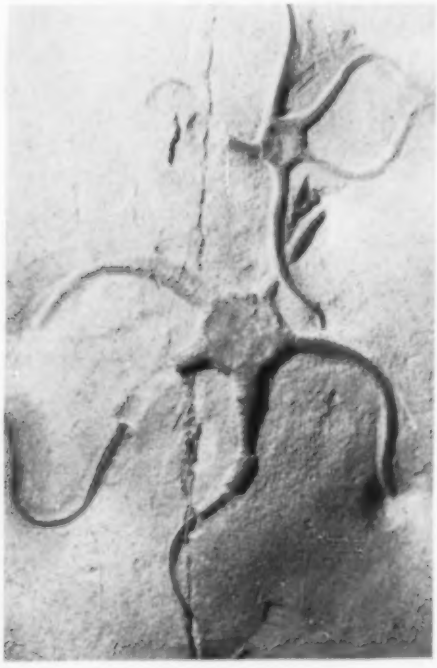


FIG. 2. JURASSIC BRITTLE-STAR. ×1.

While the starfish race was still young, at the close of the Cambrian time, a certain group of them became modified, forming the class known to scientists as the Auluroids. These animals did not differ a great deal from their cousins, the true starfish, in looks, but certain structural changes took place so that this type developed an entirely new line with new and different habits. The Auluroids lived for a span of some 225,000,000 years, dying out during the Carboniferous Age at the time when great beds of coal were being formed. Apparently the structural change which they evolved from the true starfish proved unsuccessful so that they could not combat certain changes in their habitat. Before they died out they gave rise to a new line which survived from that time on and is found living in our present seas. These are the brittle-stars. As is true to-day the brittle-stars were never as abundant in the seas of the past as were the true starfish. At their greatest extent, which was towards the close of Jurassic time (Fig. 2), there were only

23 kinds. These brittle-stars were represented by a very few at the close of our Ice Age. This is also the case with the starfish, but unlike them the brittle-stars never passed through so many rises or declines in their life's history.

We are able to trace all this history through the centuries by the fossil remains which have carefully been collected by the paleontologist. These remains, especially the earlier ones, consist of either the casts of the bodies or the actual petrified bodies themselves. It is only in the deposits, which were once soft and now have been turned to hard stone, that such remains are preserved. The skeletons of these animals do not lend themselves to preservation, for they have no solid outer shield like an oyster or snail nor do they have an internal skeleton of bones such as the vertebrates possess. Instead the body is composed of thousands of small calcareous plates held together by either a thin skin or by muscles. Thus it is necessary for the bodies to be covered quickly after death by some fine material in order to have them preserved intact. Otherwise they break apart and the plates are scattered over the ocean floor.

From the time of the fall of the starfish and brittle-stars during the Cretaceous age the type of deposits laid down were composed of such things as sands and clays, which have in general never become lithified. And also to make things more unsuitable for preservation of delicate objects, these deposits were quite often of a coarse texture. The total result was that such things as starfishes and brittle-stars are seldom preserved in their entirety in these deposits. However, the small calcareous plates which go to make up their bodies are often preserved and through them—with plenty of patience and care—the original animal can be reconstructed.

The history of the work on fossil brittle-stars is very interesting, even though brief. It was not until 1804 that Blumenback recognized the first fossil brittle-star as such, even though living Ophiurans had been described as early as 1733 by Linck, who thought their arms looked like the tails of lizards and named them accordingly. Fossils were not new to the scientists of the eighteen hundreds, for their recognition goes back to the days of Leonardo da Vinci. From 1804 until the end of the nineteenth century these animals occupied the minds of many geologists, who continuously discovered and described many new kinds. However, with the opening of the twentieth century the scientists' attention was drawn away from them

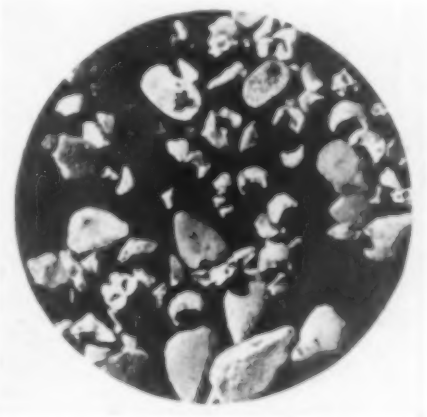


FIG. 3. PLATES FROM TERTIARY BRITTLE-STAR. ×4.

into other fields, so that since then practically no work has been done in this field.

In 1930 the present author opened up a new method of studying these little-known fossils. In that year, while searching through some of the unconsolidated Miocene sediments from Maryland, he discovered numerous small curiously shaped calcareous plates (Fig. 3), which later proved to be those which made up the skeletons of the brittle-stars. Not until that time had the plates been recognized for what they were, and it was generally thought that such sediments did not contain the remains of

these animals. Since then the author has continuously shown that these small animals are more numerous in the Tertiary deposits than anybody supposed and that not only their individual plates, but often the entire animal is preserved in snail shells, where apparently they had gone to hide during the day and had become entombed by sands and muds which covered the shell. All these can be found if only enough care is taken in searching for them.

The similarity of the fossil starfish to the living ones, which often advance in great numbers on an oyster bed, is shown by a find in some Devonian deposits. There is an area of about 200 square feet of muddy sandstone in New York State which contains upwards of 400 individual starfish. All these are of the same kind, and associated with them are a great number of fossil clams. The explanation is that these starfishes were in the midst of a meal when a great deal of sand suddenly covered them and in due time they became fossils. Other deposits such as this are known but none where so many individuals were concerned.

Have you ever watched a living starfish walk or had it move across your hand? If so, you have seen the innumerable small feet. These small feet have cups on their ends and are controlled by a water system within the animal. If he wants to fasten these feet to an object he withdraws the water from them forming a vacuum cup at their extremities which will hold firmly to any rock or shell. When he wants to let go, all he does is to pump the water back into the feet and the vacuum cups are turned inside out, thus releasing the hold. It is by this method of deflation and inflation of his tube feet that he can move along or cling to any object. This type of locomotion sharply separates the starfish from their living cousins, the brittle-stars, which do not have such tiny feet. Instead they move by pulling themselves ahead by the ends of their arms. This same difference in walking existed hundreds of years ago. However, in those early days the brittle-stars and the starfishes could not move their arms about easily, because their structure made them very stiff. This is especially true of the brittle-stars, for as time has passed their arms have become more and more flexible, as is shown by the placement of certain teeth on some of their tiny plates.

In the starfish there is a broad groove on the under side of each arm which is literally full of these tiny feet. Compare this with the under side of the arm of a brittle-star, and one does not see such feet. Instead if he looks carefully he will see innumerable pairs of small holes covered by very minute scales or plates. Sometimes through these openings will protrude what looks like a foot, but it is not. Long ago when the Auluroids separated from the starfishes and then the brittle-stars branched from them, there were radical changes produced in the skeletons of these animals, and with these changes many of the organs of the body changed in both position and function. The broad groove on the under side of the starfish became narrower until in the brittle-stars it was arched over by plates. With this arching over the feet were restricted to tiny openings and lost their function as feet and took on another function, that of respiration. The brittle-stars can draw in these breathing organs at will, closing the openings with the tiny cover plates if conditions warrant such action.

The seas were extremely devoid of different kinds of brittle-stars as well as the true starfishes during later geologic time—that is from the Cretaceous period until the close of the great Ice Age. In the opening period—the Eocene—there were two types of brittle-stars which inhabited European waters, for they are represented by fossil remains in England and Belgium. Another type occu-

pied seas of the same age in the western hemisphere, for their remains have been found in New Jersey. In the next period—the Oligocene—there is a single representative of these animals and that one comes from Mississippi, none having been found in other parts of the world. The Miocene seas apparently contained more of such animals, for North America is credited with three types and Australia and Poland with one each. Of those from North America one came from California and the other two from Maryland. Only one brittle-star of Pliocene age has been found, and that comes from Trinidad. Towards the close of the Ice Age of Pleistocene time the seas contained more brittle-stars than at any time since the Cretaceous, for nine different kinds have been found fossil in deposits of that age.

A parallel condition prevailed with regard to the true starfish, but they were in general two or three times more numerous during this time.

Why do we have so few fossils of both these animals during this period of time which embraces about 55,000,000 odd years? The answer is not in the least simple but very complex. One part of it is that they were not as numerous in the seas of that time as they were before or since. Another part is the fact that the sediments of these periods were not so conducive to preservation as the earlier ones were. And also—since they are poorly preserved—it requires more work on the geologists' part to make anything out of them. Hence they have been ignored for the sake of easier problems.

Upon tabulation of the entire number of both brittle-stars and starfish one finds that there are known only a little over 80 different kinds of fossil brittle-stars against some 1,400 living ones. A like contrast is shown when one considers the true starfishes, for these have been found only about 290 different fossil representatives of a family which has 750 different kinds swarming in the seas to-day. This shows conclusively how little is known of these animals from their fossil remains.

FIG. 1. MAGNETIC AND IONOSPHERIC OBSERVATORY, HUANCAYO, PERU
DEPARTMENT OF TERRESTRIAL MAGNETISM, CARNEGIE INSTITUTION OF WASHINGTON. COURTESY OF THE DIRECTOR.

THE IONOSPHERE

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THE region of the atmosphere at elevations greater than about sixty kilometers above sea level is heavily ionized and consequently is termed the "ionosphere." At high altitudes there are several hundred thousand molecules that have lost an electron and the same number of free electrons in each cubic centimeter. There are also ions in the atmosphere below sixty km; for example, there are on the average several hundred ions per cubic centimeter in the air at sea level and several thousand at twenty km above sea level.

The ionization of the atmosphere at high levels was discovered by means of radio waves in 1901; it was first measured by radio waves in 1924, and has been investigated since then by means of radio waves. From one point of view the investigation may be regarded as purely academic, and the ionosphere as just another geophysical phenomenon of interest to the geophysicist. From another point of view the ionosphere possesses a very practical aspect. It is essential to long distance radio communication, for all radio messages to distances greater than about 100 miles are by means of radio waves which have traveled from the transmitter to the ionosphere and have been reflected by the ionosphere down to the receiver. The waves get around the curve of the surface of the earth by successive reflections between the earth and the ionosphere. Thus an understanding

FIG. 1. MAGNETIC AND IONOSPHERIC OBSERVATORY, HUANCAYO, PERU
DEPARTMENT OF TERRESTRIAL MAGNESTISM, CARNEGIE INSTITUTION OF WASHINGTON. COURTESY OF THE DIRECTOR.

FIG. 2. MAGNETIC AND IONOSPHERIC OBSERVATORY, WATHEROO, WESTERN AUSTRALIA
DEPARTMENT OF TERRESTRIAL MAGNESTISM, CARNEGIE INSTITUTION OF WASHINGTON. COURTESY OF THE DIRECTOR.

of the ionosphere, its storms and calms, its variations with day, night, latitude, season and sunspots, is of fundamental importance to the successful maintenance of long-distance radio circuits.

An ionosphere station for routine recording of ionospheric measurements is relatively elaborate and expensive, for it requires complicated sensitive electrical apparatus and trained operators. Since the ionosphere surrounds the earth, a number of widely distributed stations are necessary for a complete and continuous survey. The first established station was that of the United States National Bureau of Standards at Washington, D. C., latitude 39° north, which commenced operation in 1930. It was the pioneer in the development of automatic recording equipment, and its hourly records by means of the equipment have been continuous since May, 1933.

Ionosphere equipment was installed several years ago by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington in its stations at Huancayo, Peru, latitude 12° south, and at Watheroo, Western Australia, latitude 30° south. Automatic recorders were recently installed in these two stations and the results are beginning to be reported. More or less complete data during various years, for the most part since 1933, have been obtained by stations at Tromsö, Norway, 70° north, at Slough, England, 52° north, at Tokio, Japan, 36° north, and at Central China College, Wuchang, 30° north. The last station ceased operation in June, 1938, due to war conditions. Ionospheric measurements for short periods of about a year or less have been carried out at various places—for example, at Deal, New Jersey, 40° north, in 1933 and 1934, and at Northeast Land, 80° north, in 1935 and 1936, and at several north polar latitude stations during the International Polar Year 1932–1933.

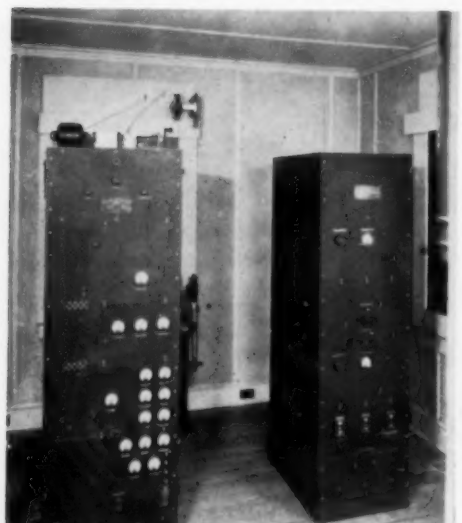

FIG. 3. AUTOMATIC MULTIFREQUENCY RECORDER

IONOSPHERE STATION, MEADOWS, MARYLAND, UNITED STATES NATIONAL BUREAU OF STANDARDS, WASHINGTON. COURTESY OF THE DIRECTOR.

At the present time there are seven ionosphere stations functioning, or preparing to function, with complete equipment, namely; Tromsö, 70° north; Slough, 52° north; Washington, 39° north; Tokio, 36° north; Huancayo, 12° south; Watheroo, 30° south, and Sydney, Australia, 34° south. The northern latitudes are adequately covered except for a considerable lacuna in the lower latitudes between 36° north and 12° south. Consideration is being given to the establishment of a station at a latitude around 15° north in India under the direction of Professor M. N. Saha. In south latitudes there are three stations. It appears that at least one more station south of the equator would be desirable, as, for example, a station in latitude 40° south, in New Zealand or South America. A station in high latitudes around 80° would be of interest, but due to geographical difficulties the establishment of such a station does not appear probable.

The Washington ionosphere station of the United States National Bureau of

Standards publishes monthly the average ionospheric data of each month. It also distributes a weekly bulletin giving ionosphere measurements of the week and data of ionospheric storms and disturbances, together with radio information derived from the ionospheric data such as the optimum radio frequencies for communication to various distances at various hours of the day. The other stations publish their data quarterly or more or less intermittently. The ionosphere station is the radio weather observatory and its data are the weather conditions for radio traffic.

An ionosphere measurement consists of a series of experiments which require about five minutes for their performance. The measurement is based on the radio echo method developed by Dr. G. Breit and Dr. M. A. Tuve in their pioneer exploration of the ionosphere in 1925 at the Department of Terrestrial Magnetism of the Carnegie Institution. A radio transmitter is arranged to send out a short pulse, about 1/1000 second in length, of radio waves of a desired radio frequency. The pulse is recorded by a nearby receiver, either in the same room or building with the transmitter or within a distance of a few miles. A single pulse from the transmitter usually produces two or more pulses in the receiver, one of which is due to waves that have passed directly to the receiver, the "ground" wave. The other pulses are due to waves that have traveled up to the ionosphere and have been there reflected back to the earth again; they are the "sky" waves, and the pulses are their echoes. One half of the time difference between the ground pulse and the echo multiplied by the velocity of light in vacuum gives the optically equivalent height or the "virtual" height, of the ionized region where reflection occurred.

The radio frequency of the transmitted pulse is then increased step by step and the echo observation is repeated at each

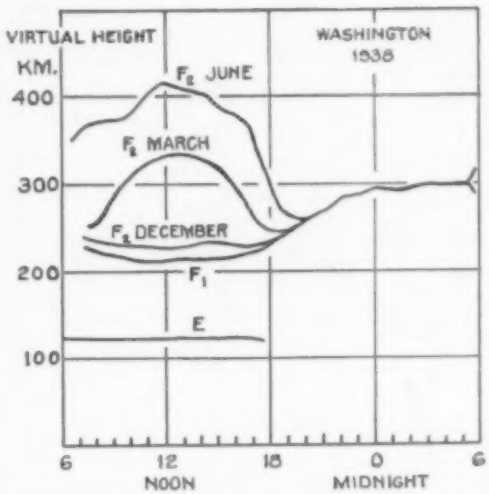

FIG. 4. MONTHLY AVERAGE VIRTUAL HEIGHTS OF IONOSPHERIC REGIONS, 1938, WASHINGTON.

step. When the radio frequency becomes high enough the waves penetrate the region of ionization and are no longer reflected from it. From the observed frequency at which penetration begins the density of ionization, n, of the region may be calculated. The quantity, n, is usually the number of electrons per cubic centimeter on the assumption that the ionization is composed of an equal number of negative electrons and positive ions. If there is another region of ionization of greater density situated above the region which has been penetrated, echoes are reflected from it and continue to be reflected until with increasing frequency penetration again occurs. Finally the frequency becomes so high that all regions of ionization are penetrated and there are no more echoes. In this way the virtual heights and densities of all the regions of ionization are mapped out.

The radio frequencies of the transmitted pulses are usually included in the range from 500 to 16,000 kilocycles per second. The received pulses are registered on automatic recording equipment. Several minutes are required for the transmitter to sweep through the frequency range and for the echoes to be

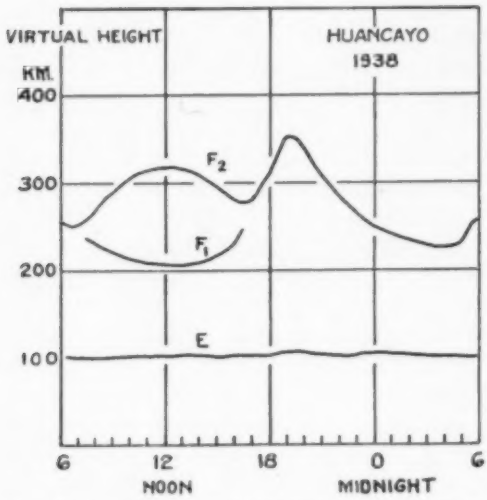

FIG. 5. MONTHLY AVERAGE VIRTUAL HEIGHTS OF IONOSPHERIC REGIONS, 1938, HUANCAYO.

recorded. In the most recent equipment four or more measurements are made each hour. It has been found desirable for each station to average the values of the virtual heights and electron densities for each hour of the day throughout the days of the month. In this way daily and seasonal variations are revealed and effects of sudden and erratic changes are smoothed over.

Although the transmitted pulses sweep continually through the broadcast frequency range and various commercial high frequency bands, the pulses are too short to be heard or to cause disturbance in the ordinary radio receivers. The ionosphere echo receivers, on the other hand, are troubled by high-power radio transmitters and must be located so as to avoid interference from them.

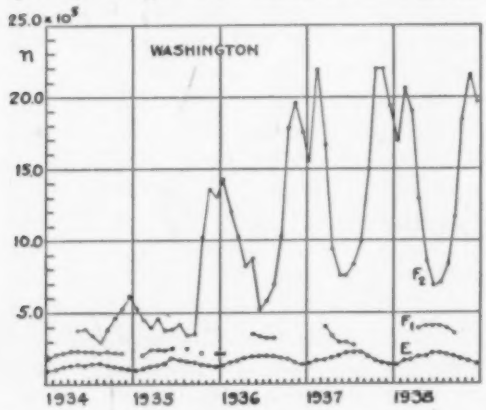

FIG. 6. MONTHLY AVERAGE NOON VALUES OF ELECTRON DENSITY N OF IONOSPHERIC REGIONS, WASHINGTON.

It is found that during the day there are three main regions of ionization in the ionosphere and two at night. These are designated by E, F_1 and F_2 for day and by E and F for night, the daytime regions F_1 and F_2 coalescing to form the night F region. In Figs. 4 and 5 are given the virtual heights of the ionospheric regions in 1938 at Washington for various seasons and at Huancayo averaged over the year. There was little change in the virtual heights with the season at Huancayo; this station, latitude 12° south, is near the equator and no great seasonal effects would be expected. The virtual heights at Northeast Land, latitude 80° north, were similar to those at Washington, and likewise for those at Watheroo but with a six-month shift of phase.

The true height of a region above sea level is always less than the virtual height and may be estimated from the virtual height, but not always very exactly. For E, F_1 and F_2 the true height is rarely more than 40 km below the virtual height, but for F_2 the difference may be as much as 100 km. From the data of Washington, Huancayo and other stations it appears that the true height of E above sea level is between 100 and 130 km and remains within these limits for day, night, latitude and season. The region F_1 is at about 200 km above sea level and its altitude varies less than about 40 km with the latitude and season. The night F region is at about 250 km above sea level, the variation with latitude and season being less than about 50 km. The virtual height of F_2 exhibits pronounced changes with the time of day, the latitude and with the season in temperate latitudes. It increases

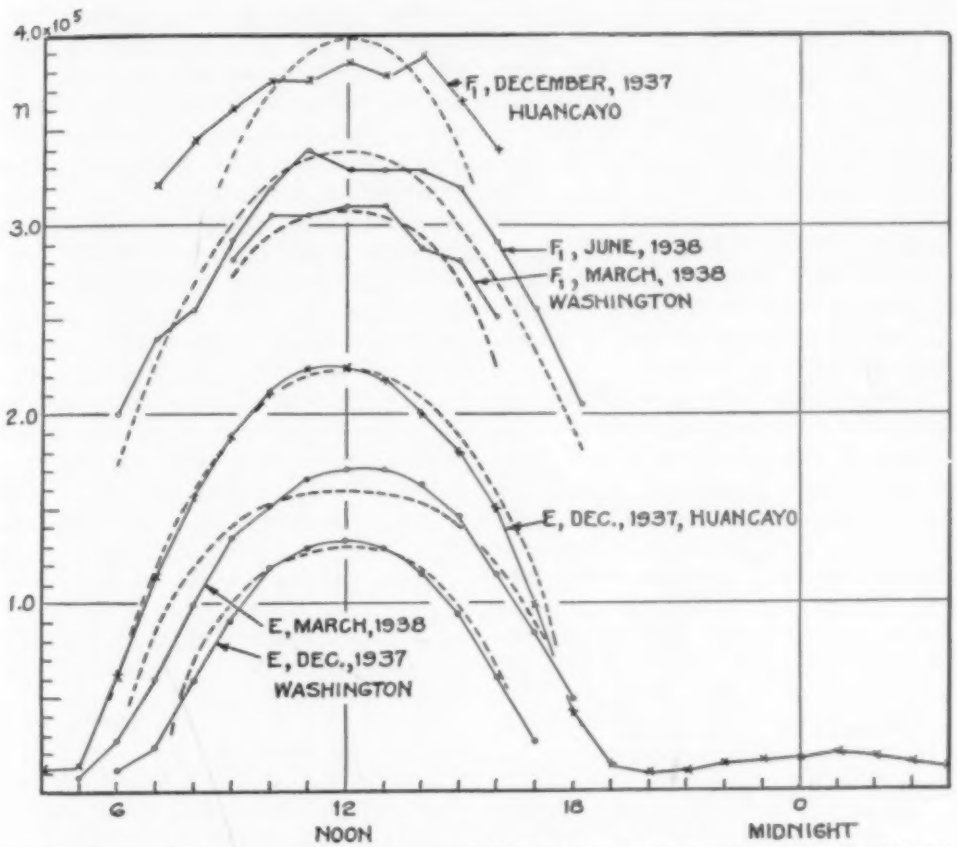

FIG. 7. MONTHLY AVERAGE VALUES OF ELECTRON DENSITY N OF E AND F_1 FOR VARIOUS SEASONS AT WASHINGTON AND HUANCAYO. DOTTED CURVES CALCULATED FROM THEORY.

to a maximum value at about noon at all latitudes north and south, the noon values at Washington being about 400 and 240 km for summer and winter, respectively; the virtual height at Huancayo the year around being similar to that for summer conditions at Washington. The true height of F_2 probably follows the virtual height changes but with less amplitude. There were no important changes in the virtual heights with increasing sunspots from 1933 to 1938.

The electronic density n is greater for F_2 than for F_1 and greater for F_1 than for E. This is natural, because a region of ionization lying above a lower region can only be observed in the case that it is of greater density of ionization; if it were of less density it would be shielded by the underlying region from the terrestrial observer. The monthly average noon values of n for Washington for 1934 to 1938 are plotted in Fig. 6. The ionization density n of all regions increased during these years, which were a period of increasing sunspots. The yearly average sunspot numbers were 5.7, 8.7, 36.1, 79.7, 114.4 and 110.3, respectively, for 1933, 1934, 1935, 1936, 1937 and 1938; 1933 was the minimum and 1938 the maximum of the sunspot cycle. It appears that n of F_2 experienced a greater augmentation with sunspots than n of E or F_1.

Fig. 6 also brings out the fact that F_1 usually appears only when the noon zenith angle of the sun is less than about

40°. The region, F_1 appears mainly during the summer months at Washington, and is usually in evidence at Huancayo during the daylight hours at all seasons. On the whole F_1 is of minor interest, appearing to be a sort of protuberance on or near the lower side of F_2. It plays little part in radio wave propagation, for the reflection of radio waves usually occurs from F at night, from E during the day in tropical and summer temperate latitudes, and from F_2 during the day in winter temperate and polar latitudes.

It is not known what types of ions constitute the various ionospheric regions, except that electrons form a part of all regions. Some theoretical calculations suggest that F_2 contains atomic oxygen and nitrogen ions, F_1 atomic or molecular nitrogen ions and E molecular oxygen ions. To investigate the question by direct experiment on the ionosphere promises to be difficult, and it seems probable that for some time any answers will come from a combination of laboratory experiment and theoretical conjecture.

The diurnal variation n of E and of F_1, illustrated in Fig. 7, is fairly regular and reaches a maximum value at about noon; in general for these regions n increases with decreasing solar zenith angle. The diurnal and seasonal variation in n of F_2 are complex, some of the data being in the curves of Fig. 8. At Huancayo, and at Washington in summer, F_2 has two maxima, a ragged and erratic maximum near noon and a higher, broader maximum in the afternoon near sunset. In winter at Washington n of F_2 has only a single maximum around noon which is greater than the summer day maxima. The value of n of F_2 is at all times more variable than the altitude of E or F_1, its value at any particular hour sometimes varying as much as forty per cent. from day to day. During the night n of F decreases, having, however, occasional temporary increases of as much as 50 per cent. During nights in midwinter at Washington a minor recrudescence of F ionization in the small hours of the night is the rule rather than the exception.

The variations of n with latitude for E and F_2 are shown by the average noon values plotted in Figs. 9 and 10. In Fig. 9 the data of Northeast Land, Tromsö

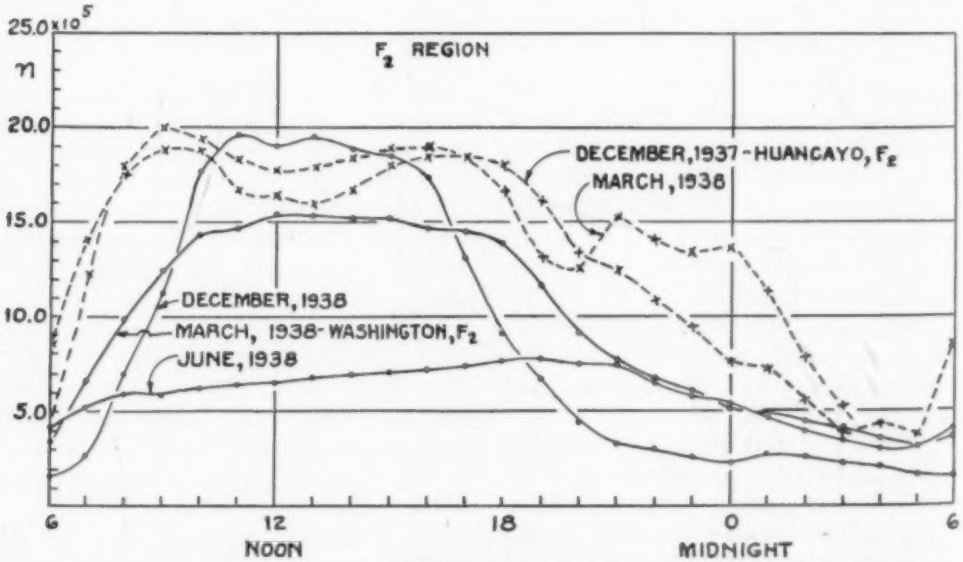

FIG. 8. MONTHLY AVERAGE VALUES OF ELECTRON DENSITY N OF F_2 FOR VARIOUS SEASONS AT WASHINGTON AND HUANCAYO.

and Washington were for 1936, and of Huancayo for 1938; there were available no data for 1938 at Northeast Land and at Tromsö, and for 1936 at Huancayo. It is justifiable to compare the data for the two different years at the various stations, since the Washington E values were much the same in 1936 and 1938. The F_2 values of Fig. 10 comprise practically all available noon F_2 data. Again, it appears from Figs. 9 and 10 that n increases with decreasing solar zenith angle.

We may summarize the foregoing facts and describe the main world-wide features of the ionosphere known at the present time. The E and F_1 regions are fairly simple, lying at about 100 and 200 km levels, respectively. Since density of ionization of each is a maximum directly under the sun, the E region fades to low values during the night and the F_1 region is swallowed up on the twilight circle by the descending F_2 region. The F_2 region is more complicated. It swells out toward the sun, spreading out through altitudes of perhaps 220 to 400 km, and contracts back to a 250 km level in the twilight zone. Its density of ionization is always greater and more variable than those of the E and F_1 regions. In tropical latitudes its density of ionization has two maxima, an irregular one around 10 A.M. and a larger, smoother one near sunset; in temperate latitudes there is a single maximum in winter and in summer there are two maxima similar to those in the tropics, except that often the morning maximum is ill defined. During the night the F ionization diminishes at all latitudes with irregular ups and downs.

Since the ionization of the ionospheric regions increases during the day and diminishes at night, there is no difficulty in believing that the most important cause of the ionization is radiations from the sun, but not the light which reaches the terrestrial observer. It is believed that the ionization is due to very short wave radiations which are completely absorbed

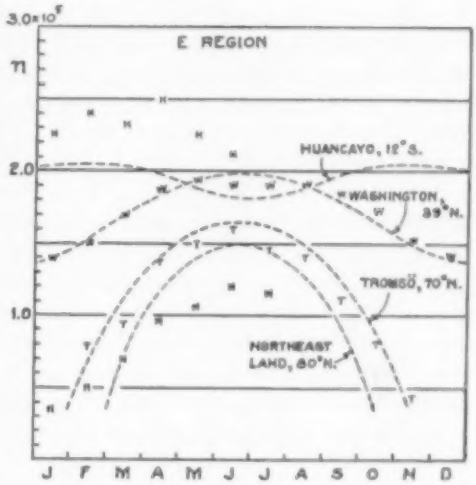

FIG. 9. MONTHLY AVERAGE NOON VALUES OF N OF E SHOWN BY INITIAL LETTER OF STATION; DATA OF NORTHEAST LAND, TROMSÖ AND WASHINGTON FOR 1936 AND OF HUANCAYO FOR 1938. DOTTED CURVES CALCULATED FROM THEORY.

in the high levels of the atmosphere, for in laboratory experiments such radiations do ionize gases. The view is taken that the observed ionization is the result of two opposing factors one being a rate of production of ionization by the action of solar ultra-violet light in splitting neutral air molecules and atoms into negative electrons and positive ions, and the other being a rate of loss of the ionization by recombination of the electrons and ions to form neutral air particles. The density of ionization which exists at any place and time depends on the values of the two rates. The simplifying assumptions are made that the rates of ion production and recombination are fairly rapid, that winds and movements of the high atmosphere are not great enough to modify appreciably the distribution of the ionization and that the character of the high atmosphere, such as pressure, temperature and constitution, is constant over the earth.

In Fig. 7 the dotted curves were calculated under the assumption that the rate of ionization depends only on the zenith angle of the sun, with the noon value n_0 adjusted for each curve to give the best

fit with the measured values. It is seen that the theoretical values agree well with the changes in n of E during the daylight hours; in the case of n of F_1 the agreement is not close. In Fig. 9 the dotted curves were calculated with $n_0 = 2 \times 10^5$ for all stations; it appears that the changes of n of E at noon with the season at any station are in fair accord with the simplified theory of a quiet atmosphere. Fig. 9 also brings out the fact that for any season n of E at noon falls off more rapidly with latitude than would be expected from theory; the observed values of n are below these calculated by about 0, 10, 20 and 30 per cent. at latitudes 0°, 40°, 70° and 80°, respectively. The suggestion has been made that the E region of the atmosphere may not be exactly of the same character at all latitudes, but that, for example, the temperature or molecular dissociation may vary from the equator to the poles; and that this variation may cause a change with latitude in the rate of recombination in such a way as to account for the moderate discrepancy between theory and observation.

In the case of the diurnal variation of F_2, given in Fig. 8, there is no question but that the simple theory of a quiet atmosphere misses the facts by a wide margin, for theory yields a single maximum in n at noon, whereas n has a double maximum at Washington in the summer and at Huancayo the year round.

To explain this phenomenon, it is assumed that in levels above about 250 km there is an expansion of the atmosphere underneath the sun, due to the effects of sunlight in heating the high atmosphere and in dissociating oxygen and nitrogen molecules into atoms. The expansion spreads out the atmosphere in the vertical direction and reduces the electron density in the F_2 region. Thus in the tropics n begins to increase in the morning due to the increasing light intensity, but soon the expansion in the air reduces the number n in a unit volume in spite of an increase in the total number of electrons in a vertical column of the atmosphere. Hence n passes through a maximum in the morning. In the afternoon the march of events is reversed; the total ionization decreases with the lowering sun, but the contraction of the atmosphere is sufficiently rapid to effect an increase in n of F_2 for a time and to cause it to pass through a second maximum in the afternoon.

There is another effect which is a consequence of the expansion hypothesis. Due to the expansion of the F_2 atmosphere, winds in levels above 250 km blow away in all directions from the region directly beneath the sun. Westward from the sub-solar point, and hence in the morning hemisphere, the stream of F_2 air moves against the rotation of the earth, is checked and becomes turbulent as the white-capping waves in a tide-rip, whereas eastward, and hence in the afternoon hemisphere, the stream moves with the direction of rotation of the earth and remains smooth and undisturbed. The effects are in accordance with the observations of F_2 which at the equator record a greatly disturbed and erratic layer in the morning and a less disturbed ionization in the afternoon, with a broad maximum at 6 or 8 P.M.

The expansion and wind theory provides a qualitative explanation of the seasonal variation of the noon values of F_2 ionization. In Fig. 10 are plotted practically all reported monthly average noon measurements of n of F_2. From the curves it is seen that in the northern hemisphere n has a midwinter minimum, attributed to winter weakness of ionizing light, and a deeper midsummer minimum, attributed to summertime expansion and winds. In southern latitudes the march of noon n of F_2 should be the reverse, or displaced six months in phase, from what it is in northern latitudes. In so far as data at Washington, 39° north, and at Watheroo, 30° south, may be compared, this is roughly true in that the curves

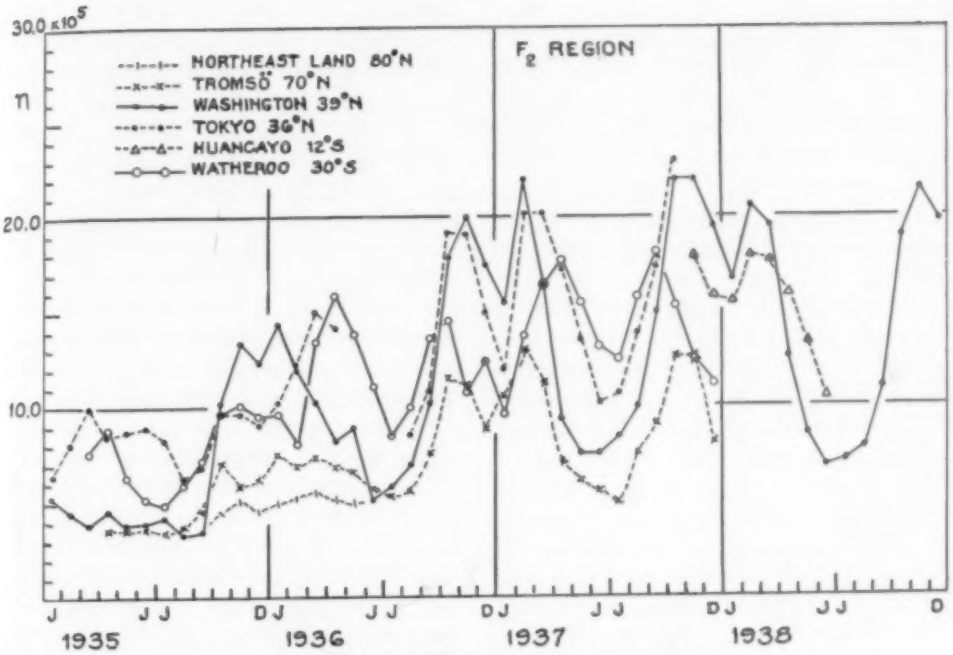

FIG. 10. MONTHLY AVERAGE NOON VALUES OF N OF F_2.

of these stations in Fig. 10 cross near equinox. The comparison should be made at two stations at equal latitudes north and south. Further data from southern latitudes would be desirable.

There are several ionospheric effects which are not explainable by a simple theory of ion production by solar radiation in a quiet atmosphere. It is often observed that pulses of radio frequencies above the penetrating frequencies of the normal *E* region suddenly begin to be echoed back from the *E* region, indicating the *E* ionization has suddenly become a better reflector or scatterer of the high frequency pulses. The phenomenon is known as "sporadic" *E;* it usually lasts only a short time, for a few minutes or an hour. Sporadic *E* echoes are local and do not occur simultaneously at stations a few hundred kilometers apart; they are infrequent near the equator, increase in frequency with the latitude, and in temperate latitudes occur both day and night. The sporadic *E* echoes are not correlated with other types of ionosphere irregularities or thunderstorms or other known phenomena. A reasonable suggestion has been made that the echoes arise from scattering by clouds or irregularities of ionization caused by winds. The optical analog is the white caps of the waves on a windy sea, which scatter much more light than is reflected by a calm water surface (hence they are white caps). If the suggestion is true, the area of ionic irregularities must often be considerable, several hundred square kilometers or more.

The ionization of both *E* and *F* regions, although in general decreasing during the night in accordance with the notion of recombination and no production of ions at night, is often observed to undergo nocturnal augmentation. Whether the enhancement is due to effects in the atmosphere, as scattering by ionic clouds due to winds ("white cap" theory), generation of ionization by collisions of excited or combining atoms ("spon-

taneous generation" theory), night cooling of the region warmed during the day ("contraction" theory), or by effects external to the atmosphere, as meteors ("interplanetary debris" theory), stellar radiations ("cosmic radiation" theory), or by some other effect ("angel" theory), can not be said. There is no dearth of suggestion and no lack of difference of opinion.

An important type of ionospheric disturbance which occurs only on the illuminated half of the earth is that associated with radio "fade-outs." Attention was first called to the phenomenon by Dr. J. H. Dellinger and much is now known about it as the result of investigations carried out by him and his colleagues of the Washington ionosphere station and by the staff of the Huancayo station. The fade-out is a sudden disappearance of radio signals for a few minutes, the complete process of fading out and reappearing occupying a time usually less than an hour. The strength of the radio signal falls to zero in usually less than a minute, the effect being simultaneous throughout the sunlit hemisphere of the earth and most intense directly under the sun. By means of cooperation with the Mt. Wilson solar observatory it was observed that radio fade-outs occurred at times when there were unusually bright hydrogen eruptions on the surface of the sun. Ionospheric observations showed that the fade-out was caused by a sudden increase of ionization at or slightly below the *E* level, which produced heavy absorption of the radio signals. Therefore the evidence is fairly complete that the ionization which occasions the fade-out is produced by a sharp burst of radiation from a hydrogen eruption on the surface of the sun which travels in straight lines from the sun to the earth with approximately the velocity of light. The radiation is in all probability ultra-violet light.

This is the first instance in which the cause of a definite unusual terrestrial circumstance has been traced, almost beyond doubt, to a definite unusual happening on the sun. The hydrogen eruption usually, but not always, occurred near an active sunspot group. The numbers of known ionospheric disturbances of the fade-out type were 17, 103 and 220 in 1935, 1936 and 1937, and thus increased rapidly with the increase of sunspots in these years.

In the foregoing paragraphs, the relation of ionospheric phenomena to radio wave propagation has barely been touched upon, while its relation to terrestrial magnetism has not been mentioned at all. An adequate discussion of these important topics is too long to be included here.

MAN'S CREATIVE YEARS IN MUSIC

By Professors HARVEY C. LEHMAN and DeFOREST W. INGERHAM
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In what years is the best work done? What are the chronological ages at which men are most likely to compose delightful and immortal music? Perusal of the literature discloses almost every conceivable answer to the foregoing questions. For example, Phelps states that musical composition appears at early ages,[1] Dorland believes, on the other hand, that the best music is composed late in life.[2] Still another writer asserts that there are two types of geniuses, one of which matures early, the other late,[3] and Pitkin assures us that "Musical genius, high and low alike, flowers early and continues in bloom throughout life."[4] From these mutually contradictory statements what is one to conclude? What are the facts?

It is obvious of course that unsupported assertions prove nothing. To the critical student it is equally obvious that the method used by Dorland, that of simply naming a large number of men of a given chronological age who have composed noteworthy musical selections is of questionable validity. Before accepting conclusions that are based upon what are alleged to be "illustrative cases," the critical student will insist upon knowing whether the illustrations are really typical or whether they are very exceptional. By the selection of some exceptional cases and the omission of others, it is possible to make an apparently strong case for almost any preconception whatsoever. But for impartial study of the creative years an adequate method is needed—a method which takes account of both exceptional and typical instances. Accurate conclusions regarding the chronological ages at which men have most frequently composed various types of superior music will involve therefore: (1) Assembling a reasonably large random sampling of various types of superior music, and (2) determining for the composers of each type of music the average number of compositions per chronological age level.

In previous articles[5] the fact has been stressed that when age differences in creativity are being studied proper allowance should be made for the fact that individuals do not always live to a ripe old age. Some die early; others die during middle age. Therefore, since the representatives of the younger age groups are always more numerous than the representatives of the older age groups, the younger age groups might conceivably accomplish more merely because of their greater numerical strength. Computation of the average number of achievements of each age group eliminates this difficulty.

Several additional facts should be considered. It obviously is not possible to study the entire life work of persons who are still living and achieving. There is no way of knowing what such individuals may accomplish during their later years. The present study includes for the most part, therefore, data for deceased com-

[1] W. L. Phelps, *The Reader's Digest*, 24: 79–81, 1924.

[2] W. A. N. Dorland, "The Age of Mental Virility," The Century Co., New York. Pp. vii + 229, 1908.

[3] H. Harvey-Day, *Magazine Digest*, 11: 85–86, 1935.

[4] W. B. Pitkin, "The Psychology of Achievement," Simon and Schuster, New York. Pp. xi + 502, 1931. (See p. 205.)

[5] (a) H. C. Lehman, THE SCIENTIFIC MONTHLY, 43: 151–162, 1936; (b) H. C. Lehman, THE SCIENTIFIC MONTHLY, 45: 65–75, 1937.

posers.[6] For these the record is complete, and future research will probably change it only slightly, if at all.

Grand Opera

Data for the production of grand opera will first be submitted. In his "Cyclopedia of Music and Musicians,"[7] W. S. Pratt presents dates of first publication[8] for more than 2,000 grand operas that were composed by more than 500 individuals. With the foregoing information, together with the birth and the death dates of the composers, it has been possible to obtain the average number of operas that were produced at each successive chronological age level.

In Fig. 1 the solid line presents the chronological ages of 134 Italian composers at the time 650 of their grand operas were either first produced or first published. In studying the solid line in Fig. 1 it should be remembered that this curve presents the average number of operas per chronological age level.

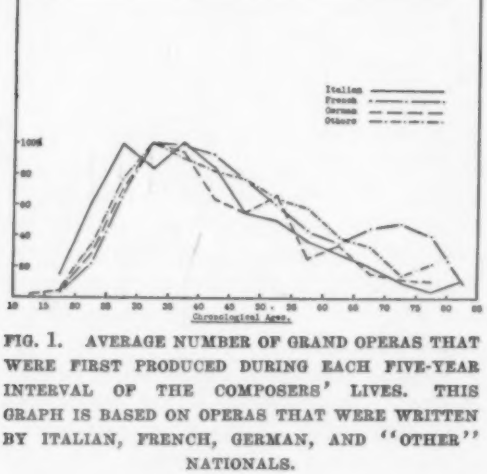


FIG. 1. AVERAGE NUMBER OF GRAND OPERAS THAT WERE FIRST PRODUCED DURING EACH FIVE-YEAR INTERVAL OF THE COMPOSERS' LIVES. THIS GRAPH IS BASED ON OPERAS THAT WERE WRITTEN BY ITALIAN, FRENCH, GERMAN, AND "OTHER" NATIONALS.

[6] There will be two exceptions to this rule. These exceptions will be noted when they occur.

[7] W. S. Pratt, "The New Cyclopedia of Music and Musicians," The Macmillan Co., New York. Pp. vi + 967, 1924.

[8] Pratt states: ". . . where dates are given they are usually those of first performance or publication." Reference 7, p. 180.

Proper allowance is thus made for the larger number of youthful composers.

For example, for the 134 Italian composers whose works are set forth in Fig. 1, it was found that 130 of them published 24 grand operas at age 35. This was slightly more than an average of .18 of an opera per individual. Of these 130 composers, 85 were alive at age 60. The 85 composers surviving at age 60 published only 6 operas, which was slightly more than .07 of an opera per living individual. In Fig. 1 the solid line is so drawn as to be only about a third as high at age 60 as at age 35, thereby indicating that the average number of grand operas was only about a third as great at age 60 as at age 35.[9]

If, regardless of the number of composers that remained alive, the men of age 60 had produced operas at the same average rate as did the men of age 35, the solid line in Fig. 1 would remain as high at age 60 as at age 35. However, the curve descends very markedly at the older age levels. Is this decrement due to loss of ability to compose grand opera? Or is it perhaps due to certain other factors which accompany advance in age?

[9] In constructing the graphs that accompany this article, the data for each of them were first reduced to a comparable basis by the following procedure: The peak of each statistical distribution was arbitrarily assigned a value of 100 per cent. and the other averages within the same statistical distribution were assigned proportionate percentage values. For example, in Fig. 1, the peak of the distribution for the Italian composers occurred at ages 35 to 39 inclusive. At this latter age interval the average number of grand operas per composer was .165. In the solid line of Fig. 1 the decimal .165 is plotted therefore as 100 per cent. At the age interval 65 to 69 inclusive, the average number of operas per composer was .035. This latter decimal fraction is equivalent to 21 per cent. of the maximum production (21 per cent. of .165) and in Fig. 1 the decimal .035 is plotted therefore as 21 per cent. The foregoing method of plotting should be borne in mind when studying the graphs.

A Comparison of Four National Groups

In Fig. 1 the solid line presents data for Italian composers only. The three remaining lines of Fig. 1 present data for French, German and "other" nationals. In general, these age-curves reveal striking similarity. As regards the production of grand opera, significant and consistent changes seem to occur with advance in chronological age regardless of nationality. In Fig. 1 it is apparent that: (1) All four of the curves rise somewhat more rapidly than they descend; (2) each curve remains at nearly its maximum height for a period of ten to fifteen years; and (3) the Italians appear to compose more operas at the younger age levels than do the composers from the other countries.[10] This latter finding will perhaps be most easily understood by those who have traveled in Italy and who have observed that in Italy even the small boys on the streets are likely to be heard whistling the airs of the well-known operas.

The Best-loved Grand Operas

Fig. 1 is based upon data that were available in Pratt's "Cyclopedia of Music and Musicians." Since Fig. 1 presents data for more than 2,000 operas, this figure does not yield definite information as to when the best-loved operas were produced. The production of the grand operas that are most preferred by music lovers is revealed in Fig. 2. The data that were employed for the construction of Fig. 2 were obtained from the ninth edition of "The Victor Book of the Opera."[11] This latter volume is

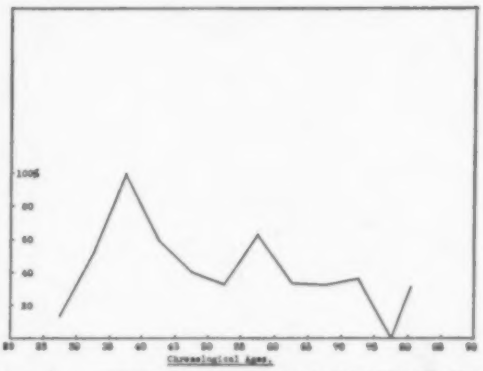


FIG. 2. AVERAGE NUMBER OF BEST-LOVED GRAND OPERAS THAT WERE FIRST PRODUCED DURING EACH FIVE-YEAR INTERVAL OF THE COMPOSERS' LIVES. THIS GRAPH IS BASED ON 82 OPERAS BY 38 COMPOSERS.

the result of an attempt to select only those grand operas that possess lasting value and that opera-goers are most likely to hear.[12] In the preface of the foregoing book the editors make the following explanatory statement:

> It has been our aim to make the present edition of *The Victor Book of the Opera* as representative as possible by including all the Standard operas regularly played in the repertoire and the newer operas that seem to be of permanent interest.

If it be granted that the above-mentioned purpose has been attained by the compilers of "The Victor Book of the Opera," it seems evident that the grand operas that are most preferred by opera-goers have been composed most frequently by men of ages 35 to 39 inclusive.

Critical readers may wonder whether the shape of the curve in Fig. 2 is not perhaps due to the particular book that was employed for obtaining data. Might

[10] The method of plotting the curves might have given rise to an erroneous conclusion at this point but, as may be seen by study of Table II, no such error has occurred. Table II reveals clearly that, prior to age 30, the average number of operas per composer is definitely greater for the Italians than for any of the three other groups.

[11] "The Victor Book of the Opera," RCA Manufacturing Co., Camden, New Jersey. Pp. 526, 1936.

[12] In the construction of Fig. 2 data for a few living composers were included. However, their inclusion did not influence appreciably the shape of the age-curve. Perhaps it should be mentioned also that, although a few comic operas are listed in "The Victor Book of the Opera," the comic operas were excluded when data were assembled for the construction of Fig. 2.

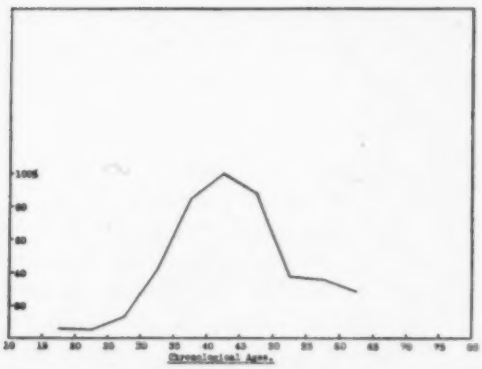


FIG. 3. AVERAGE NUMBER OF LIGHT OPERAS AND MUSICAL COMEDIES THAT WERE FIRST PRODUCED DURING EACH FIVE-YEAR INTERVAL OF THE COMPOSERS' LIVES. THIS GRAPH IS BASED ON 121 COMPOSITIONS BY 54 INDIVIDUALS.

not other books that list the noteworthy grand operas yield curves of quite different shape? The present writers sought an answer to the foregoing question by separate study of seven additional opera guides[13] (eight books in all) which purport to list the best-liked operas.

What was found when age-curves were drawn by using data obtained from these eight books? The eight age-curves were found to differ in no essential respect from the curve that is shown in Fig. 2. Each of the eight curves attained its maximum height and each curve exhibited a rather narrow peak at the age interval 35 to 39 inclusive.

[13] (a) G. Kobbe, "The Complete Opera Book," G. P. Putnam's Sons, New York. Pp. xxii + 993, 1935; (b) J. W. McSpadden, "Opera Synopses," Thomas Y. Crowell & Co., New York. Fifth edition, Pp. xviii + 493, 1934; (c) G. P. Upton, "The Standard Operas," Jansen, McClurg & Co., Chicago. Pp. 343, 1886; (d) P. England, "Fifty Favourite Operas," Harper & Brothers, New York. Pp. xvii + 605, 1926; (e) *Reclams Opernführer. Herausgegeben* von Georg Richard Kruse. *Zweite, erweiterte Auflage. Verlag* von Philipp Reclam jun. Leipzig. Pp. 526, 1928; (f) E. Newman, "Stories of the Great Operas and Their Composers," Garden City Publishing Co., Inc., Garden City. Pp. 322–335, 271, 1930; (g) "The Victrola Book of the Opera," Victor Talking Machine Co., Camden, New Jersey. Eighth edition. Pp. 428, 1929.

Light Opera and Musical Comedy

Fig. 3 presents data for 121 light operas and musical comedies that were written by 54 individuals from six different countries.[14] Among the 54 composers are Germans, Frenchmen, Englishmen, Americans, Italians and one Russian. Perusal of the 121 titles will serve to convince any impartial reader that, collectively, these are very superior works of their particular kind. For these light operas and musical comedies the peak of the age-curve occurs at ages 40 to 44 inclusive, which is five years later than the peak for the production of favorite grand operas. (See Fig. 3.)

In Fig. 3 notice the rather narrow age-range during which the majority of the light operas were produced. As will appear later, for most types of musical composition that have been studied by the present writers, the most preferred works seem to have been composed during a somewhat narrower age-range than was the aggregate of the same type of composition.

Orchestral Music

Whereas, Figs. 1 to 3 inclusive are based upon the chronological ages of the composers at the time of first performance or first publication, Fig. 4 on the other hand reveals the ages of the composers *at the time of composition*. Thus, Fig. 4 presents composite age-curves that were constructed by the use of data obtained from: (1) Three source books[15] which list orchestral selections of lasting popularity, and (2) six source books[15,16]

[14] J. W. McSpadden, "Light Opera and Musical Comedy," Thomas Y. Crowell Co., New York. Pp. xxi + 362, 1936.

[15] (a) J. N. Burk (Editor), "Philip Hale's Boston Symphony Programme Notes," Doubleday, Doran & Co., Inc., New York. Pp. xix + 400, 1935; (b) C. O'Connell, "The Victor Book of the Symphony," Simon and Schuster, Inc., New York. Pp. xviii + 530, 1934; (c) G. P. Upton and F. Borowski, "The Standard Concert Guide," A. C. McClurg & Co., Chicago. Pp. 551, 1930.

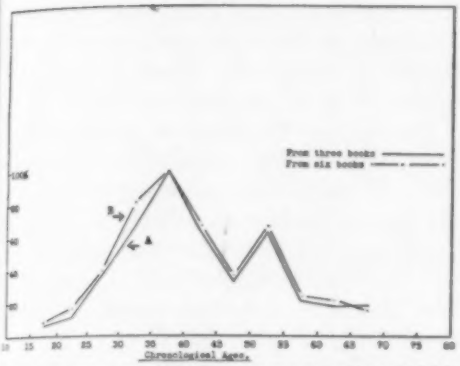


FIG. 4. AVERAGE NUMBER OF ORCHESTRAL SELECTIONS OF LASTING POPULARITY THAT WERE COMPOSED DURING EACH FIVE-YEAR INTERVAL OF THE COMPOSERS' LIVES. COMPOSITE CURVES BASED ON: (A) THREE BOOKS AND (B) SIX BOOKS—WHICH LIST FAVORITE ORCHESTRAL WORKS.

(which number includes also the three source books).

In constructing the composite curves which are set forth in Fig. 4 each orchestral selection was counted as often as it was listed. Thus, when the three source books were being examined, a selection that was listed in each of the three books was tallied three times, a selection that was listed in only two of the three source books was given two credits, and a selection that was mentioned in only one book was counted only once. This procedure is based upon the assumption that those orchestral selections which are listed by a larger number of compilers are more popular than are the selections which are listed less frequently. This measure of merit, although it is obviously a crude one, is perhaps sufficiently accurate for the purpose for which it has been used.

The two curves in Fig. 4 reveal that only a slightly different curve is obtained when six books instead of only three books are utilized for obtaining data. This finding suggests that the data possess internal consistency. Note that both of the curves in Fig. 4 exhibit rather narrow peaks, a characteristic which has received previous comment. It seems apparent that the orchestral selections which are most popular with music lovers, and which have withstood the test of time, have been composed most frequently by men of ages 35 to 39 inclusive. This was not necessarily the most prolific period of the composers of these works, but it was the most productive of works considered superior by posterity.

CONTEMPORARY MUSIC VERSUS MUSIC THAT HAS ENDURED

In Fig. 5 the data for the dash-line were obtained from still another, a seventh, book of orchestral selections, namely, from Olin Downes's "Symphonic Masterpieces."[17] This dash-line, which presents data for 53 superior orchestral selections by 19 composers (now deceased), corroborates the findings that were set forth in Fig. 4. This curve reveals once again that the best-loved orchestral selections have been composed most frequently by individuals

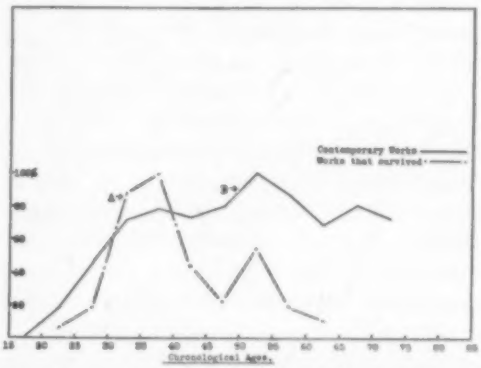


FIG. 5. ORCHESTRAL WORKS. (A) ORCHESTRAL SELECTIONS THAT HAVE SURVIVED, AND (B) ORCHESTRAL SELECTIONS WRITTEN BY CONTEMPORARY AMERICANS BETWEEN THE YEARS 1912 AND 1932.

[16] (a) L. Gilman, "Stories of Symphonic Music," Harper & Brothers, New York. Pp. xvii + 359, 1907; (b) G. P. Upton, "The Standard Symphonies," A. C. McClurg & Co., Chicago. Pp. xii + 321, 1903; (c) P. H. Goepp, "Symphonies and Their Meaning," (First and Second Series), J. B. Lippincott Co., Philadelphia. Pp. xx + 498, 1908.

[17] O. Downes, "Symphonic Masterpieces," The Dial Press, New York. Pp. xix + 294, 1935.

who were from ages 35 to 39 inclusive at the time of composition.

The solid line in Fig. 5 presents data for contemporary American composers whose works have been listed by Claire Reis.[18] In the foreword of her compilation Reis makes the following explanatory statement:

> In order to present a complete picture of the outstanding works written during the past twenty years . . . this second edition of *American Composers* has been compiled. . . . Although it may seem arbitrary to include only works written between 1912 and 1932, yet a score of years is a fair exposition of contemporary music. It is the purpose of the editor . . . to present this material with less emphasis on the complete historical survey than on the original work which has come out of this country in the last twenty years.

In Reis's volume data are presented separately for different types of music. It was possible, therefore, to tabulate separately the data for orchestral works by living American composers. It perhaps should be mentioned that many of the modern orchestral selections that are listed by Reis are still in manuscript form, not having as yet been published.[19]

Fig. 5 reveals that, whereas the orchestral selections which to-day are most preferred by music lovers have been composed most frequently by men of ages 35 to 39 inclusive, contemporary American composers, on the other hand, have produced their greatest volume between the ages of 50 and 54. However, these latter works have not yet met the test of time. Note the marked difference in the shapes of the two curves of Fig. 5. The age-curve for the contemporary American composers sustains itself well until beyond age 70, whereas, the age-curve which sets forth the most esteemed works of the deceased composers descends sharply after age 37 is attained.

In studying the two age-curves of Fig. 5 one can hardly refrain from speculation. Were the contemporary Americans composing the best as well as the greatest quantity of their music from ages 50 to 54? Or does quality of musical composition decline at earlier age levels than does quantity of composition?

Cantatas

Fig. 6 presents dates of composition for cantatas. In his book, "The Standard Cantatas,"[20] George P. Upton gives short sketches of 73 cantatas. In the appendix of this same book Upton presents a somewhat more exhaustive catalogue of 247 cantatas. The list that is given in the appendix includes also the cantatas that appear in the table of contents. It seems obvious that Upton places in his table of contents, and discusses in the body of his book, those cantatas which

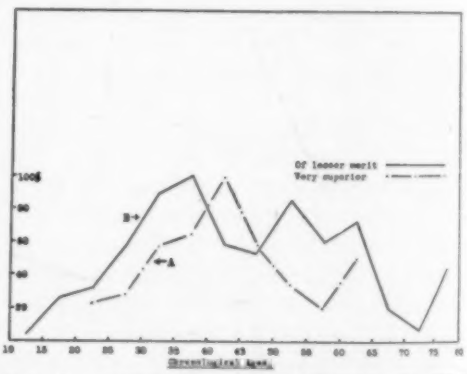


FIG. 6. CANTATAS. (A) CANTATAS OF VERY SUPERIOR MERIT, AND (B) CANTATAS OF SOMEWHAT LESSER MERIT. GROUP (B) INCLUDES GROUP (A).

he regards as having greatest merit. The 247 cantatas that are listed in the appendix are evidently regarded by Upton as

[18] C. Reis, "American Composers," second edition, published by the United States Section of the International Society for Contemporary Music, New York. Pp. 129, 1932.

[19] Since some of this contemporary music was written in 1912 and was still unpublished in 1932, one can hardly avoid the suspicion that some of it is destined to remain forever unpublished.

[20] G. P. Upton, "The Standard Cantatas," A. C. McClurg & Co., Chicago. Pp. 367, 1888.

of lesser average importance than the cantatas which are given space in the body of his book. For the more selective list which appears in the table of contents, the average number of cantatas per composer is 1.92; for the more inclusive list which appears in the appendix the average is 3.80.

In Fig. 6 the dash-line sets forth the ages of the composers at the time of composing the more selective list of cantatas (that which appears in the table of contents). The solid line in Fig. 6 presents analogous information for the cantatas that are listed in the appendix. Fig. 6 suggests that, as compared with the larger aggregate, the more important cantatas (those best-liked) are more often composed during a somewhat narrower age-range. This conclusion is suggested by the fact that the age-curve for the more selective list of cantatas reveals a rather rapid rise and decline, whereas the curve for the more inclusive list of cantatas exhibits a wider spread.

Symphonies

Fig. 7 sets forth, for symphonies, age-curves that are analogous to those that are presented in Fig. 6 for cantatas. In Fig. 7 both age-curves are again based upon dates of composition. The data for

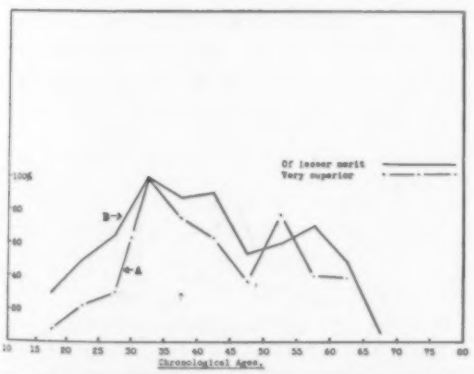


FIG. 7. SYMPHONIES. (A) SYMPHONIES OF VERY SUPERIOR MERIT, AND (B) SYMPHONIES OF SOMEWHAT LESSER AVERAGE MERIT. GROUP (B) INCLUDES GROUP (A).

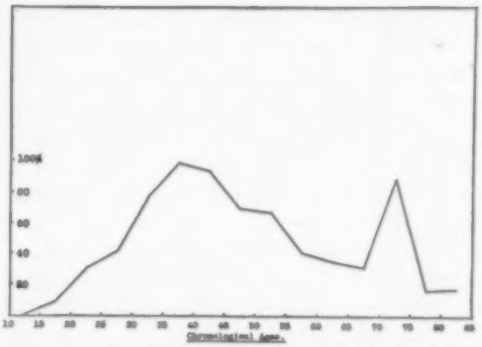


FIG. 8. AVERAGE NUMBER OF CHAMBER MUSIC SELECTIONS THAT WERE FIRST PUBLISHED DURING EACH FIVE-YEAR INTERVAL OF THE COMPOSERS' LIVES. THIS GRAPH IS BASED UPON 970 SELECTIONS BY 283 DECEASED COMPOSERS.

both of the curves of Fig. 7 were obtained from another of Upton's books, "The Standard Symphonies."[21] In Fig. 7 the dash-line is again employed for setting forth the chronological ages of the composers at the time of composing the 56 symphonies which Upton lists in his table of contents and which he evidently regards as very choice selections. And the solid line presents data for the 231 symphonies that are to be found in the appendix of Upton's book.[22] For the more selective list of symphonies (that which comprises the table of contents) the average number of compositions per composer is 2.33; for the more inclusive list (that which is found in the appendix) the average is 3.91. Fig. 7 implies that the best-loved symphonies, like the best-loved cantatas, are composed during a somewhat narrower span of years than are symphonies of lesser merit.

Chamber Music

Fig. 8, which presents dates of first publication[23] for 970 selections of cham-

[21] G. P. Upton, "The Standard Symphonies," A. C. McClurg & Co., Chicago. Pp. xii + 321, 1903.

[22] A few symphonies had to be omitted because the dates of composition were not available.

[23] W. W. Cobbett, "Cobbett's Cyclopedia of

ber music that were composed by 283 individuals, attains its peak at the age interval 35 to 39. However, when dates of composition (which were available for 179 chamber music selections by 37 composers) were plotted separately, the peak of production was found to occur at ages 30 to 34 inclusive.

In Fig. 8 a very marked rise in the age-curve may be observed at the age interval 70 to 74. Two individuals are chiefly responsible for this phenomenon, namely, Max Bruch (1838–1920), who published 9 chamber music selections at age 72, and J. D. Artot (1803–1887), who published 12 selections at this same advanced age. It seems unlikely that these 21 selections were all composed at so late an age. It seems much more likely that in the case of both Bruch and Artot there was a considerable time-lag between the dates of composition and the date of first publication. If the latter hypothesis is valid, the unusual rise at the right of the curve in Fig. 8 is due to exceptional time-lag between date of composition and date of first publication rather than to exceptionally late composition.

Other Types of Music

Fig. 9 reveals the chronological ages at which 301 vocal solos were either composed or first published by 29 noted composers. The foregoing statement refers to the music, not to the words, of the vocal selections. Although, for some of these vocal solos, only the dates of first publication were available, for most of them the dates of composition were obtained. Some of the data for constructing Fig. 9 were obtained from the biographies of individual composers,[24] but most of the data were procured from the 1927 edition of "Grove's Dictionary of Music and Musicians."[25]

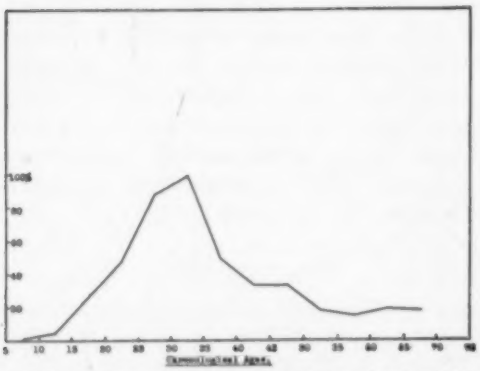


FIG. 9. AVERAGE NUMBER OF VOCAL SOLOS THAT WERE EITHER COMPOSED OR FIRST PUBLISHED DURING EACH FIVE-YEAR INTERVAL OF THE COMPOSERS' LIVES. 301 SOLOS BY 29 COMPOSERS.

It goes without saying that not all the 301 solos that are pictured in Fig. 9 are really noteworthy vocal selections. However, in obtaining the data for Fig. 9, selections were utilized only when mentioned specifically by name or by opus number, and when either the date of composition or the date of first publication was available. For example, in Schauffler's biography of Beethoven it is recorded that during one year Beethoven arranged the accompaniments to 25 Scotch songs. It seems likely that the latter figure may perhaps be a mere estimate. In any event, probably not all the 25 accompaniments were of great importance. It is here assumed that if both the name of the composition and its date have come down to us, tabulation thereof will provide a fair sampling of the composers' better vocal selections.[26]

[24] (a) R. H. Schauffler, "Beethoven: The Man Who Freed Music," Doubleday, Doran & Co., Inc., New York. Pp. 693, 1935; (b) H. Bidou, "Chopin," (translated by Catherine Alison Phillips), Tudor Publishing Co., New York. Pp. 267, 1925; (c) W. Niemann, "Brahms," (translated from the German by Catherine Alison Phillips), Alfred A. Knopf, New York. Pp. xiii + 492, 1930; (d) S. Kaufman, "Mendelssohn: A Second Elijah," Tudor Publishing Co., New York. Pp. xiv + 353, 1936; (e) C. D. Bowen and B. von Meck. "Beloved Friend": The Story of Tchaikowsky and Nadejda von Meck.

[25] H. C. Colles (Editor), "Grove's Dictionary of Music and Musicians," Third edition, The Macmillan Co., New York. Five volumes, 1927.

[26] Since the songs of many of the composers

Chamber Music," Oxford University Press, London. Two volumes, 1929.

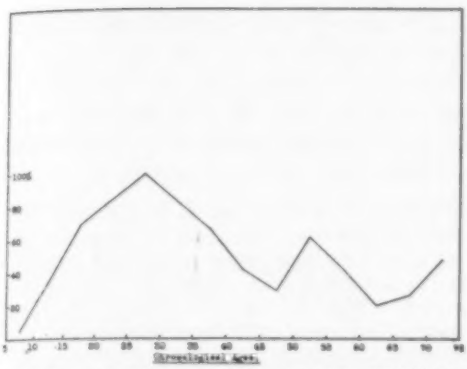


FIG. 10. AVERAGE NUMBER OF INSTRUMENTAL SELECTIONS THAT WERE EITHER COMPOSED OR FIRST PUBLISHED DURING EACH FIVE-YEAR INTERVAL OF THE COMPOSERS' LIVES. 287 SELECTIONS BY 34 COMPOSERS.

Fig. 10 presents information regarding 387 instrumental selections, mostly pianoforte and violin pieces, by 34 noted composers. Most of the comments that appear in the preceding paragraph regarding method of selection are applicable also to Fig. 10. Instrumental selections were tabulated only when mentioned specifically by name or by opus number, and when either the date of composition or the date of first publication was available. Both biographies[24a] and "Grove's Dictionary of Music and Musicians" were employed as sources of information. In Figs. 9 and 10 the age differences in creativity are clearly apparent. In each instance the peak of the age-curve appears prior to age 35. Further comment regarding Figs. 9 and 10 is perhaps unnecessary.

CONTEMPORARY MUSIC

Fig. 11 sets forth data for 1,286 miscellaneous musical compositions by 131 contemporary Americans. The data for this graph were obtained from Reis's "American Composers." It will perhaps be recalled that Reis presents what she describes as "the outstanding works" that were written by American composers between the years 1912 and 1932, and that many of the 1,286 compositions have not yet been published. Note that the age-curve in Fig. 11 attains its peak at ages 50 to 54 inclusive, and that this curve sustains itself rather well from ages 30 to 70.

The 1,286 musical selections that were listed by Reis were classified by her according to type of composition. For four of the five types of music for which Reis presents data, the apogee of production occurred beyond age 45. Considered in the light of the other data that have been presented herein, two hypotheses will probably occur to the reader, namely: (1) As compared with the composers of an earlier day, contemporary Americans continue to compose music at older age levels, and (2) both the composers of to-day and those of the past have endeavored to produce music during most of their mature years but, for a group of individuals, the peak for quality of composition occurs at an earlier age level than does the peak for quantity of composition.

It would be difficult, if not impossible, to produce unequivocable evidence in support of either of the foregoing hypotheses. A newspaper writer advanced

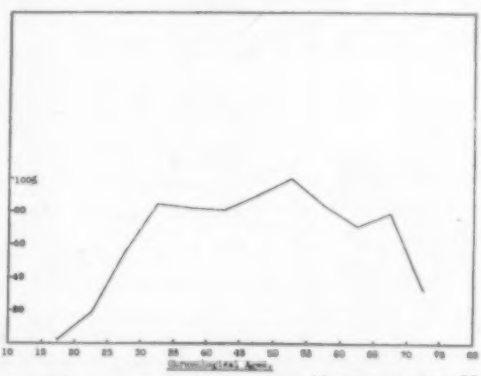


FIG. 11. AVERAGE NUMBER OF "OUTSTANDING" MISCELLANEOUS MUSICAL SELECTIONS THAT WERE WRITTEN BY CONTEMPORARY AMERICANS BETWEEN 1912 AND 1932. 1,286 SELECTIONS BY 131 COMPOSERS.

are to be found in their operas, only a sampling of their vocal selections could be obtained by this procedure.

the hypothesis that, as compared with men who lived in earlier days, modern man is able to maintain his vigor, and thus to continue his output, over a longer period of time. Therefore, it was argued, it might well be that the contemporary Americans were writing the best as well as the greatest quantity of their music from ages 50 to 54. If the foregoing arguments be valid, it is of course possible that future generations will esteem most highly the compositions that were written by the contemporary Americans when the latter were beyond 50 years of age. The latter hypothesis is submitted not as a belief of the present writers but merely as one of several hypothetical possibilities.

The preceding paragraph sets a problem for the future. Tastes change, and there is at present no sure method for determining what future generations of music-lovers will acclaim.[27] Regardless of future appraisals, the following evi-

[27] It is of interest that no composition by a deceased feminine composer is listed by the critics and historians whose works were employed in the present study. It seems apparent that modern critics do not esteem very highly the musical selections that have been written by women. Since a considerable number of feminine composers are listed in Reis's "American Composers," (See Reference No. 18) one is led to wonder how many of the works of these feminine composers will meet with the approval of future generations. And why have there been no (or only a very few) outstanding feminine composers heretofore?

TABLE I

SUMMARY OF FINDINGS WITH REFERENCE TO MUSICAL COMPOSITIONS†‡

Type of music	Source of data	No. of works	No. of composers	Average number of works per composer	Median age	Average or mean age	Standard deviation	Years of maximum productivity
Grand Opera (by Italians)	7	650	134	4.85	36.36	37.92	12.05	35–39
" " (by French)	7	569	108	5.26	40.31	42.37	14.85	30–34
" " (by Germans	7	458	142	3.23	38.80	39.87	10.65	30–34
" " (by others)	7	690	214	3.22	39.28	40.96	12.25	30–34
Grand Opera (best-liked)	11	82	38	2.16	41.25	45.12	11.88	35–39
Grand Opera (best-liked)	13a	144	61	2.36	42.64	44.44	11.45	35–39
" " " "	13b	114	39	2.92	42.92	45.40	11.55	35–39
" " " "	13c	62	22	2.82	40.50	43.47	11.10	35–39
" " " "	13d	47	21	2.24	40.50	43.14	10.65	35–39
" " " "	13e	92	43	2.24	40.70	43.48	11.80	35–39
" " " "	13f	29	11	2.64	41.00	45.78	12.73	35–39
" " " "	13g	89	34	2.62	42.20	44.07	12.20	35–39
Light Operas and Mus. Com.	14	121	54	2.24	42.17	42.71	9.60	40–44
Orchestral Music (best-liked)	15a	93	23	4.04	38.38	40.01	10.65	35–39
" " " "	15b	69	20	3.45	36.69	38.15	8.50	35–39
" " " "	15c	154	36	4.28	37.36	40.10	10.75	35–39
" " " "	16a	38	11	3.45	39.00	38.70	11.95	*
" " " "	16b	56	24	2.33	38.50	40.71	11.25	30–34
" " " "	16c	33	12	2.75	36.50	39.62	10.10	*
" " " "	17	53	19	2.79	37.83	40.14	9.58	35–39
Orchestral Music (Contemporary)	18	510	124	4.11	36.31	38.60	10.10	50–54
Cantatas (The aggregate)	20	247	65	3.80	39.23	43.07	12.95	35–39
" (A select list)	20	73	38	1.92	40.00	40.03	9.80	40–44
Symphonies (The aggregate)	21	231	59	3.91	37.80	38.95	12.30	30–34
" (A select list)	21	56	24	2.33	39.17	40.71	11.25	30–34
Chamber music	23	970	283	3.43	41.11	42.54	13.90	35–39
Vocal solos	24 and 25	301	29	10.38	31.47	33.43	11.45	30–34
Instrumental selections	24 and 25	387	34	11.38	30.28	33.00	14.15	25–29
Sacred choral music	30	111	37	2.97	45.25	46.01	14.50	35–39
Violin Concertos	31	214	103	2.08	42.08	41.87	15.25	40–44
Misc. contemporary music	18	1,286	131	9.82	36.30	38.02	9.75	50–54

* Insufficient data for determining the peak of production.

† G. P. Upton, "The Standard Oratorios," A. C. McClurg & Co., Chicago. Pp. 335, 1887.

‡ F. B. Emery, "The Violin Concerto," The Violin Literature Publishing Co., 331 West Ohio Street, Chicago. Pp. 615 + xl, 1938. Age-curves were constructed which reveal when oratorios and violin concertos are most frequently composed but these curves have not been published herein because of lack of space. The essential findings regarding these two types of musical composition are set forth in Tables I and III.

dence leads the present writers to assert that, according to present-day standards of judgment, quality of musical composition declines at earlier age levels than does quantity of composition.

To the writers it seems highly probable that the less important works of the less important deceased composers have not always been preserved for posterity and that, in many instances, no record of these less important compositions is available. Significant in this connection is the fact that the following phrases often appear in histories of music: "only fragments extant," "not given and score destroyed," "many of his early works have never been published." If, for the more prominent composers, most if not all of the titles of their works are available, study of the latter should reveal something regarding the quantitative output of past generations of composers.

Quality versus Quantity

Return for a moment to Fig. 7. Some of the composers that are listed in the appendix of Upton's book, "The Standard Symphonies," are not listed in his table of contents. Therefore, since the two age-curves of Fig. 7 are not based upon compositions by the same individuals, the difference in the shapes of the curves of Fig. 7 might conceivably be due in part to the fact that the works of different composers were utilized for constructing the age-curves. As a means of studying this possibility, the writers isolated data for 19 composers whose works were listed both in the table of contents and also in the appendix of Upton's book.

TABLE II

Average Number of Musical Compositions per Five-year Interval. The Peak of Each Statistical Distribution is Italicized

	Age interval															
	5–9	10–14	15–19	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84
Fig. 1																
(Italians)	...	...	.025	.101	.164	.153	*.165*	.141	.091	.083	.061	.047	.035	.018	.008	.020
(Frenchmen)	...	...	.006	.041	.117	*.180*	.177	.167	.139	.108	.078	.064	.081	.087	.068	.016*
(Germans)	...	.003	.006	.037	.087	*.125*	.118	.080	.069	.083	.031	.043	.020	.015	.013	...
(Others)	...	.002	.005	.038	.085	*.111*	.100	.091	.085	.072	.065	.044	.038	.017	.024	...
Fig. 2																
(*The Victor Book*)	...	...	...	...	.016	.063	*.123*	.072	.049	.040	.077	.041	.041	.046	...	.067
Fig. 3																
(Light Opera)	...	...	.007	.007	.015	.049	.100	*.117*	.102	.044	.042	.034	...	...	...	...
Fig. 4																
(Three books)	...	...	.029	.048	.157	.275	*.405*	.261	.134	.259	.092	.073	.073	...	...	...
(Six books)	...	...	.022	.044	.104	.217	*.263*	.175	.096	.176	.062	.057	.043	...	...	...
Fig. 5																
(Orchestral-Downes)	...	...	...	.011	.032	.152	*.174*	.074	.039	.095	.031	.017	.028	...	...	...
(Orchestral-Modern)	...	...	.002	.050	.129	.197	.220	.203	.221	*.278*	.240	.190	.222	.200	...	...
Fig. 6																
(Select Cantatas)	...	...	...	.026	.032	.066	.074	*.113*	.065	.038	.023	.058	...	...	...	...
(Cantatas — the aggregate)	...	.006	.037	.043	.078	.120	*.135*	.079	.072	.113	.081	.098	.027	.010	.060	...
Fig. 7																
(Select symphonies)	...	...	.008	.025	.033	*.111*	.084	.070	.041	.087	.046	.045	...	...	...	...
(Symphonies — the aggregate)	...	...	.041	.068	.089	*.136*	.120	.124	.073	.082	.097	.067	.009	...	...	...
Fig. 8																
(Chamber music)	...	.001	.013	.036	.048	.092	*.117*	.113	.083	.081	.047	.042	.037	.102	.020	.021
Fig. 9																
(Vocal solos)	.007	.028	.138	.241	.455	*.511*	.256	.174	.176	.098	.082	.103	.096	...	...	...
Fig. 10																
(Instr. music)	.018	.135	.265	.323	*.382*	.317	.255	.156	.111	.232	.162	.078	.100	.180	...	...
Fig. 11																
(Misc. contemporary music)	.001	.001	.012	.108	.329	.503	.492	.486	.538	*.601*	.505	.429	.474	.200	...	...

* The average for the succeeding five-year interval, namely, for ages 85 to 89 inclusive is .087.

Age-curves were then constructed, separately for those symphonies that were listed only in the table of contents and also for those listed both in the table of contents and in the appendix. For the 19 composers the average number of their works that were listed in the table of contents was 2.53; the average number listed in the appendix was 7.68. For the more select list the peak of production occurred at the age interval 30 to 34; for the more inclusive list the apogee occurred at ages 55 to 59.

In similar manner 36 composers were isolated whose names were to be found both in the table of contents and also in the appendix of Upton's book, "The Standard Cantatas." The 36 composers had written 68 cantatas which are listed in Upton's table of contents, and 151 cantatas which are listed in the appendix. For the more select list of cantatas the peak of production occurred at ages 40 to 44; for the larger aggregate the peak occurred at ages 55 to 59.

Grand opera was studied in like manner. Twenty-five composers were found who had contributed 75 grand operas which found their way into the eighth edition of "The Victrola Book of the Opera." For the same 25 composers 398 of their works are listed in Pratt's "Cyclopedia of Music and Musicians." For the more select list of grand operas the apogee of production was found to occur at ages 35 to 39; for the larger number of their works the peak occurred at ages 50 to 54.

Although analogous data have not been assembled for every type of music, the foregoing findings are highly suggestive. It seems likely that both to-day and in former days the peak for quality of musical composition appears at earlier age levels than does the peak for quantity of composition.[28] Since quality of composition and quantity of composition are not perfectly correlated, there is no valid reason for supposing that the contemporary Americans have written their *best* music at ages 50 to 54, their most prolific period.

Concluding Remarks

If it be granted that the sources from which the foregoing data have been obtained are trustworthy sources, it seems obvious that, although men attempt to write music during most of their mature years, for at least several types of composition, the best-loved works are produced (most frequently) during a shorter span of years than are works of lesser merit. In weighing the latter assertion it should be remembered that this statement applies to groups of composers and that any extension of group description to the individual will always be open to question.

TABLE III

Age Intervals During Which Various Types of Music are Most Frequently Composed*

Ages 25 to 29
Instrumental selections.
Ages 30 to 34
Symphonies.
Chamber music (by both deceased composers and by contemporary Americans).
Vocal solos.
Grand opera (the aggregate thereof).
Ages 35 to 39
Grand opera (best-liked).
Orchestral music (best-liked).
Sacred choral music.
Cantatas (The aggregate thereof).
Ages 40 to 44
Light operas and musical comedies.
Violin concertos.
Cantatas (best-liked).
Ages 45 to 49
Stage works (by contemporary composers).
Ages 50 to 54
Orchestral music (by contemporary Americans).
Chamber orchestra music (by contemporary Americans).
Ages 55 to 59
Choral music (by contemporary Americans).

* Unless otherwise specified, the data are for deceased composers only.

Writers sometimes point to the fact

[28] A similar situation has been found to exist with reference to the writing of "best books," and data have been assembled which suggest that this generalization holds also for certain kinds of scientific endeavor. Only a part of the latter findings have been published.

that Mozart wrote four sonatas for the violin and piano at age eight, and they mention also that Mozart wrote his first symphony at this same tender age. One might point also to the fact that Mendelssohn composed his best-known work, "A Midsummer Night's Dream" at the age of 17. Those who are content to rely upon a few exceptional instances, selected to prove something, can find a number of other examples of early creativity in the field of music. But to those who have an intellectual outlook broader than that of the partisan debater, whose only desire is to maintain a pre-conceived theory, such isolated instances are of minor importance for the determination of age differences in creativity. Equally irrelevant for the latter purpose are the facts that Cesar Franck wrote his D minor symphony at age 66, Handel's marvelously beautiful "Messiah" was composed when Handel was 56, and Verdi wrote "Falstaff" when he was almost 80 years old.[29]

The relationship between chronological age and superior musical composition can be ascertained only if enough cases are assembled to yield some sort of statistical distribution. With reference to every type of human performance there are likely to be notable exceptions. However, isolated instances, and even lists of exceptional accomplishments, prove nothing at all regarding the relative creativeness of the various age groups.

Some readers who have perused this article to the present point may wonder why the writers do not advance a theory by way of explaining their findings. In the space that has been allotted them for publication of this study the writers have chosen to present factual findings with a minimum of arm-chair speculation. The decrements in the age-curves are obviously the accompaniment of later maturity. The present study does not reveal whether (for groups of composers) this decrement is the inevitable accompaniment of advance in chronological age. Nor does this study reveal specific causative factors. Indeed, solution of the latter problems may well attract the best efforts of several generations of investigators.

To some, the above findings will perhaps bring a feeling of regret. Is it possible that (for groups of composers) quality of musical composition starts declining at such relatively early age levels? In preparing this manuscript the present investigators obviously have had no choice but to report what the evidence seems to indicate.

NEW DEVELOPMENTS IN SCIENCE MUSEUM TECHNIQUES AND PROCEDURES

By ROBERT P. SHAW

DIRECTOR, NEW YORK MUSEUM OF SCIENCE AND INDUSTRY

THE technique of presenting scientific and industrial exhibits to the public has progressed a long way since the days when "half a mile of canned tomatoes" represented a high point in exhibition ideas.

The main thought behind this type of presentation, which touched the above-mentioned high a number of years ago, was obviously to impress upon the observer the importance of an industry or an achievement by staggering him with mere size or numbers. If a single can of tomatoes was a good thing in itself,

[29] Falstaff is regarded by many as Verdi's masterpiece.

then one can multiplied by many hundreds must surely be something to pause and reflect upon.

To-day, however, with the vastly increased variety of media at our command, and with a more enlightened and carefully thought-out purpose behind every exhibition program, the technique of exhibit presentation has become rather more subtle, and, we feel, considerably more effective in its approach to the public. The Chicago Century of Progress had much to do with raising the level of this technique and out of it came a number of new and useful ideas. So, too, one looks for the New York and San Francisco World's Fairs to open up valuable possibilities in this direction. And meanwhile, working along through the level stretches between the landmarks provided by such expositions, science museums and other institutions and organizations interested in the exhibition field serve as experimental laboratories where new ideas are developed and tried out—some, naturally, to be discarded, but others to become established as sound and proved methods of visual education.

If mere magnitude was the criterion by which an exhibit was measured years ago, to-day our standards are quite different. To-day, we look, first, into the value or significance of an idea and then rate it accordingly as to size of its concrete expression. For the primary purpose of any exhibit to-day is to educate, to show the public where a development, invention or discovery belongs in its own historical field and then where it belongs in the individual's every-day life. Planned by modern methods, an exhibit dealing with canned tomatoes would never, now, call in the handy man to pile row upon row of cans in one overwhelming array and let it go at that. It would call in the farmer to explain how modern agricultural methods have produced bigger, more palatable and nutritious tomatoes; the canner to describe how ripe tomatoes are picked and taken to the canning factory, there to be prepared and sealed into tins; the engineer to picture the machinery and up-to-date methods of handling that have been developed for the factory; the laboratory technician, the doctor and the dietitian to tell how research in vitamins has emphasize the importance of tomatoes in the diet and in how many ways they can be used to further the health of children and adults. All this varied information would then be analyzed and evaluated, and finally translated into the terms of modern exhibit display, actual machines, models, both static and operating, dioramas, motion pictures and other media being selected to be worked into a compact, but dramatic and many-sided picture of tomato canning as an industry in itself, and in its relation to the economic and social scheme of the twentieth century.

Keeping in mind that in these modern times the science museum must compete with the theater, motion pictures, sports events and numerous other insistent bids for the attention of the public, it will be obvious that any exhibition, whether scientific, industrial or of whatever character, must discover and put into effective use techniques of presentation sufficiently unusual to attract and hold the much-sought-after average person. Not only, therefore, are the techniques themselves of interest, but methods that may lead to their discovery are also useful.

In the following pages, we have attempted to describe some of the techniques which have been developed at the New York Museum of Science and Industry, and to suggest some of the ways in which, looking constantly toward the development of new methods, we feel out public sentiment in regard to its scientific interests.

One of the most effective ideas we have worked out recently in the field of

illumination is known as our masked lighting technique. This was developed as we were casting about for an exhibit to take the place of the famous transparent woman, which, after a phenomenally successful extended showing, was taken on a tour through the country.

This life-sized transparent figure, whose internal organs were illuminated one by one in an unusual lighting sequence, occupied the spotlight in the museum in a very literal sense for a period of six months. It was so popular, indeed, that after it left us, some two hundred or more people out of the daily attendance at the museum declared they had come specifically to see this exhibit, and were greatly disappointed not to find it. As it was not possible or practical for us at the time to construct a duplicate of this figure, and as the expense involved in obtaining one from Europe, where it was made, was prohibitive, we had to find some other way to satisfy the demand for a spectacular physiological exhibit of this character.

We did this by sending abroad for a typical medical school figure, which we named "Miss Anatomy" and with which we worked out an ingenious lighting system comprising sixteen concealed projectors to illuminate, in rotation, the various opaque organs. In order to achieve the effect desired, in which each individual organ would be brilliantly illuminated, with its natural outlines and contours thrown into sharp relief while the rest of the body would remain in darkness, the projectors were first made to serve the purpose of small cameras. By illuminating the particular area containing an individual organ and exposing a film placed in front of the projector, a pattern was obtained from which a very accurate masking was constructed to bring about the required sharp cut-off in the lighting of a given part without encroaching upon the rest of the body surface. In this way, a series of sixteen sequences was developed in which one organ after another was spotlighted while a lecturer explained its structure and function.

This masked lighting technique is as readily applicable in fields other than the physiological. It might be used, for example, in demonstrating a complicated piece of machinery or equipment where it was desired to point out and explain the important parts individually. These would be successively highlighted and coordinated, leading up to an illuminated showing of the complete mechanism. Or, again, a process could be explained by breaking down its component parts into a related series of "spotlight performances."

Our progressive exhibit method of presentation is another type of technique which has been developed here at the museum and which we have applied most intensively in our electrotechnology division. The basic idea of this technique is to present to visitors, in the form of a connected story, but with exhibition media, the outstanding discoveries and developments in a particular branch of science. In the electrotechnology division, of course, we would be dealing with the story of electrical science.

Organized by this progressive exhibit method, then, our story of electrical science is told in a series of exhibit units, each one of which deals with an outstanding phase of that story and leaves it ready to be taken up by the next unit. Each individual unit consists of four parts—operating exhibits on a working level convenient to the visitor's hand, which demonstrate the main ideas and experiments with which that unit is concerned; titles and explanatory legends on the wall background; historical exhibits in a case under the working level; and, finally, a brief printed summary, in one or two lines, at the extreme bottom, condensing into a few words the significance of the material shown.

Superimposing a number of little

theaters or scientific side-shows on an exhibition to highspot outstanding features is a new development in the field of exhibit presentation which we find makes for a livelier and more dynamic atmosphere. At our museum in New York, we have some eight of these at present. One of them is the "Miss Anatomy" show, described previously in connection with the masked lighting technique. Another consists of a lecture and spectacular demonstrations dealing with Polaroid. A third demonstrates the transparent man, and so on. Each of these can stand as a separate exhibition unit by itself, yet each is definitely associated with other exhibit material in the museum. "Miss Anatomy" and the transparent man, for instance, are features of our general "Story of Man" exhibition, presenting numerous exhibits in the field of anatomy and physiology, while the Polaroid lecture-demonstrations are supplemented by other Polaroid displays outside the auditorium where the lectures are held.

A valuable purpose served by these little theaters is that they do much to offset the well-known "museum fatigue" which frequently attacks those visiting various types of exhibition. For here, when his feet give out, with the resultant numbing effect upon his mental capacity to absorb what the visitor sees, he can sit down for awhile, and be entertained while he rests.

Tying a scientific exhibition in with a motion picture running simultaneously in the picture houses is a new procedure which we have successfully employed on more than one occasion. The program grew out of a totally unexpected development in connection with what we at first considered one of the less important items in an exhibition devoted to Thomas A. Edison and his contributions to science and industry.

This was a vote recorder developed by Edison with the idea of using it in the House of Representatives to count votes. While it never went into operation there, it served a purpose as the basis of the modern voting machine.

In order to demonstrate how the vote recorder functioned, we placed the names of a number of famous people on the machine, such as Pasteur, Lindbergh, Faraday, Napoleon, Watt, Roosevelt and others, and invited visitors to cast a vote for the one they believed to have done the most for our civilization. To our surprise, when we came to count the votes we found that one name had received thousands of votes against only a few hundred for all the rest combined. This name was that of Louis Pasteur. Looking a little further into the matter, we discovered that the reason why most of the Pasteur votes had been cast was because the voters had just seen a motion picture dealing with the life of the scientist. From this it was only a step to working out a plan by which we might supplement a current feature picture dealing with some scientific subject with an exhibition enlarging upon the same subject by presenting it from other angles.

The first picture with which we felt it would be suitable to try out this experiment was "The Adventures of Marco Polo." Our exhibition presented the famous traveler as the first scientific explorer, using the little bag given him by his father to collect samples of unusual things he saw as he roamed through the Orient, which he later introduced to western Europe. The various individual exhibits portrayed modern industries which might have found their inception in that little collection of Marco Polo's treasures, among them being coal, salt, asbestos, textiles, samples of block printing, a mariner's compass and many other things.

Our most recent venture with this type of procedure was our "Submarine Patrol" exhibition, which used the motion picture of the same name as a point of departure for a showing of submarine

and subchaser equipment, featuring an actual periscope through which the public might look; under-water sound detectors, arranged so that visitors could actually hear a propeller turning in water some distance away; a radio direction-finder, set up for visitor operation; a gyroscopic compass, a "rescue lung," models of various types of submarines and chasers, and other items. As a feature attraction on one evening, during the exhibition, we had Simon Lake at the museum, discussing the development and future of submarines before an interested audience.

Our experience in this direction to date has convinced us that many interesting stories in science and industry, told so vividly in sound films, can be given added scope and reality by exhibitions of this type, using the interest already stimulated in the public by the picture to still further extend their knowledge of the scientific subject.

Our excursion around the fringes of the motion picture field led us into still another new activity, which we called "mass screen testing." Begun as one of the features of the Marco Polo exhibition, it proved so popular that we were obliged to carry it on for some time after the original exhibition closed.

Constructing in the rotunda of the museum a reproduction of one of the stage sets from the Marco Polo film, we had a lecturer use it as a stage several times a day to give a short talk on Marco Polo, briefly explaining the scientific and industrial exhibits in the exhibition and, in speaking of the set, tell something about the art of making motion pictures. In the latter connection, he referred to the screen tests taken by actors and actresses before being cast in a picture. At the conclusion of his talk, he would invite visitors to step up on the set and be "screen tested," performing for the benefit of a hidden battery of motion picture cameras such acts as taking a head test, lighting and smoking a cigarette, using powder and lipstick, or anything else the lecturer might think at the time of having them do. Our unique camera set-up permitted the filming of several individual pictures simultaneously on separate films.

Allowing the necessary time for the developing and printing of the films, the pictures were shown in our auditorium two days later, after which the films were presented as souvenirs to the individuals who had been "screen tested."

Analyzing this procedure, which drew many thousands of men, women and children from all over the country to take the "screen tests" during the few months they were held, we found five reasons for its popularity, a combination which we promptly noted down for future reference as spelling out the requisites for a successful new technique. These we listed as (1) personal participation; (2) return visit insured; (3) bring your parents; (4) bring your friends, and (5) the souvenir feature.

One thing leading to another, as it usually does, we found in our mass screen testing the germ of still another procedure, and early last summer we began figuring out a way to lure the business executive type of person into the paths of scientific interest through his favorite sport. Starting out with an adaptation of the screen-testing idea, we at first confined our "Science Aids Golf" program to the slow motion filming of an individual swinging his golf club. Following the earlier procedure, these films also were shown two days later in the auditorium, and the films then given free to the individuals concerned.

Inspired by the interest of the serious golfer in this opportunity to actually see for himself, on the motion picture screen, where his golf swing failed to conform to the necessary technique, we next conceived the idea of a golf swing

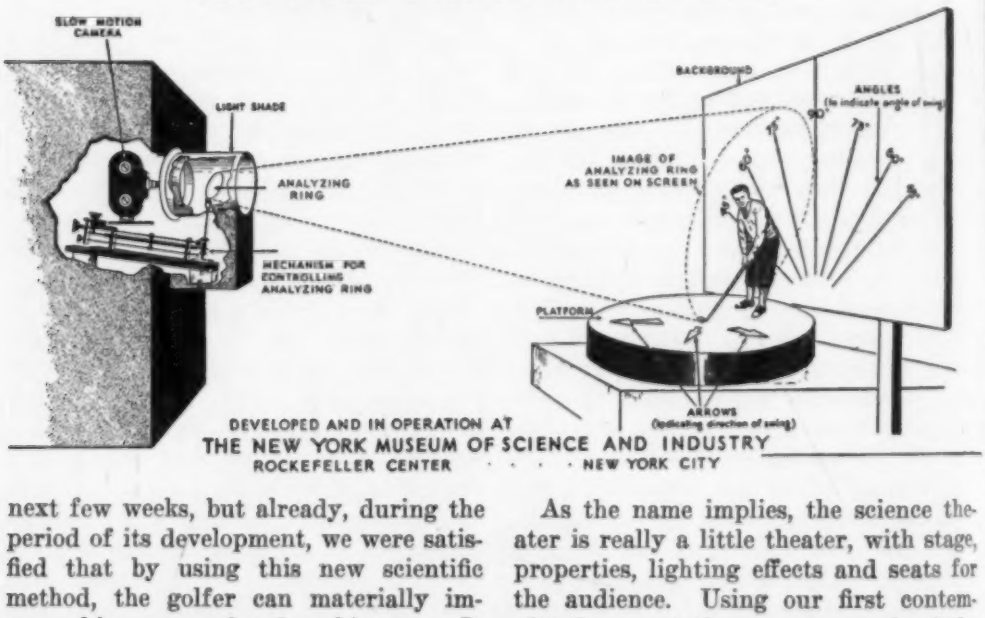
analyzer. This is a mechanism, used in conjunction with the motion picture camera, consisting of a ring, superimposed between the camera lens and the subject, and adjustable in three directions. By making slow motion pictures using this apparatus, the golfer may observe whether or not his swing follows the correct path as indicated by the machine, and, if he finds it needs correction, he can study his progress through subsequent testings.

This device, now perfected, will be put into operation at the museum within the next few weeks, but already, during the period of its development, we were satisfied that by using this new scientific method, the golfer can materially improve his game and reduce his score. It might be interesting to note that in my own case I took about ten strokes off my game, and instead of playing in the low nineties I have been consistently playing in the low eighties, and have broken eighty for the first time since I have been playing the game. Here truly is an example of how science can aid in a sport or in one's hobby.

Aside from the value of these golf tests in themselves, we have found that through them we reached people who ordinarily would not come to a Museum of Science and Industry, but who, having made this initial contact, became regular visitors.

A much more elaborate development which has come out of all this experimenting with the motion picture motif is our projected science theater, which we expect to open in the near future. This applies the screen-testing idea specifically to scientific and industrial subjects by having visitors actually perform classical experiments and demonstrations before the motion picture camera.

THE GOLF SWING ANALYZER



As the name implies, the science theater is really a little theater, with stage, properties, lighting effects and seats for the audience. Using our first contemplated presentation as an example of the type of thing we propose to do, the opening venture of the science theater will deal with the work of James Watt. Set up on the stage will be six dramatized exhibits, in the form of experiments, animated models or mechanical equipment, each of which will represent a highlight in the story of Watt. A short talk on Watt's work and its significance will precede a lecturer's explanation that a brief motion picture on this subject is about to be made, in which the

actors will be taken from the audience. He then explains and operates each of the six demonstrations on the stage, pointing out to the visitors that this is, in effect, a rehearsal of their rôles. After this, visitors who have previously registered and been assigned to specific demonstrations, go up on the stage and go through their respective parts.

In accordance with our established routine for this type of procedure, the pictures will be shown two days later in our auditorium, with the lecturer telling the Watt story again, this time coordinating it with the film shots being shown. Subsequently, those visitors who have appeared in the pictures may have the films to take home.

Our present plan is to change the subject of these science theater presentations from month to month, and it is our belief that such dramatizations of outstanding scientific discoveries, inventions and developments will do much to bring them to life for the average person.

In concluding this discussion of techniques and procedures at the New York Museum of Science and Industry it might be helpful to mention one we have found to be of great value as a guide in showing us what people make use of the museum, and also in helping us evaluate our exhibits from the standpoint of interest to the public. I refer to our daily surveys, in which staff members strolling about the museum enter into conversation with visitors and find out from them such data as how they happened to come to the museum, where they come from, what exhibits they enjoyed the most and other pertinent facts. A new part of the survey shortly to be instituted will consist of mailing letters to a certain number of visitors each month, with carefully worded questions designed to bring out fuller information as to what they got out of their museum visit, what type of exhibition might interest them in the future and what comments or suggestions they might have for the improvement of our presentations.

So far, our current surveys have shown that 43.8 per cent. of our visitors are brought to the museum by a desire to see some particular exhibit of which they have heard from some one who has already seen it, through the newspapers or magazines, over the radio or in some other of the many ways in which word gets around of things to see and places to go. Other leading questions used in the survey permit this figure to be broken down to indicate the relative attracting power of the individual exhibits. The other 56.2 per cent. of our total attendance come to visit the museum as a whole.

To-day, as never before, people are alive to what is going on about them at the moment. To meet their demands, to answer their questions and to hold their interest, it is important for those who plan any type of educational program to keep in mind that they are dealing with a public which is scarcely more than one jump behind the experts in knowing about the latest developments in all fields of modern activity. The radio, with its news commentators and specialized programs; the news reels and short-subject motion pictures; the up-to-the-minute digests of current topics found in the modern newspaper and the weekly news magazines have seen to it that the average person learns of the happenings in the varied worlds of politics, music, science, literature or any other almost as soon as they occur. If the science museum is not to be left behind, it must continually revise and adapt its techniques to keep them in character with the spirit of the times.

THE POLICEMAN ON THE BEAT

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AMERICA is vividly conscious of crime, almost jittery. Everybody discusses it; crime sells books, newspapers, lectures, movies and theater tickets, even games and toys for children. We have had a veritable rash of surveys, police shake-ups, raids, scientific and sensational publicity. However, the whole problem remains reminiscent of Mark Twain's famous *bon mot* about the weather, "Everybody talks about it, but nobody does anything."

The function of the ordinary plodding policeman is an uninteresting but a fundamentally important and much neglected topic.[1] He is to law enforcement what the infantry is to the army. Aviation, artillery, tanks, machine guns, intelligence service, etc., are much more dramatic and romantic, but doughboys and leathernecks are still indispensable for winning wars. Vice squads, detectives, homicide squads, G-men, radio experts, motorcycle men, laboratory scientists, captains and lieutenants are necessary for an efficient police force, but the undramatic routine of the ordinary patrolman is the basis and backbone of all good police work.

Yet the policeman is, and long has been, in very low repute with many Americans. Many mothers use the policeman to frighten children, along with boogeymen, fathers and germs. If you ask a young child what a policeman is, he may reply, "Why, a policeman can shoot you, or arrest you, or club you!" All over the land children play cops and robbers—and the cops do not always get the best of it; whoever wins, there is always plenty of shooting, clubbing, name-calling and dragging off to jail. The very word "cop" is an epithet with a rich vocabulary of synonyms such as dumb-cop, smart-cop, dick, bull, flatfoot, strong-back, weak-head, big-feet, little-brains, strong-arm squad, and so on. The policeman is the butt of crude mirth on stage and screen, in stories and funny pictures. Why is this? Why should there be ill-feeling between good citizens and the police?

Undoubtedly, the fault lies both with the police and the public. For example, the Boston Police Regulations instruct policemen to use no harsh, profane, violent or obscene language, always to be courteous and to control their tempers, to be civil, orderly, moral and never to discuss religious or political questions when on duty nor to work for any candidate at any time; never to ask for passes or otherwise to gain free admission to any place of amusement; specifically, never to say, "Can't you read that sign? Don't you know that is against the law?"[2] Other police regulations probably contain similar instructions. Citizens who have experience with the relatively few policemen who violate these rules fre-

[1] For example, in the recent S. Greer, "Bibliography of Police Administration and Police Science," New York, Institute of Public Administration, 1936, xv + 152, there are only a few references to this subject and they are mostly incidental. Perhaps the best books are A. Wood, "The Policeman and the Public," New Haven, 1919; O. F. Cahalane, "The Policeman," New York, 1923; R. B. Fosdick, "European Police Systems," New York, 1915, chapters 6 and 7, "The Uniformed Force," and "American Police Systems," New York, 1920, chapter 8, "Rank and File"; A. Vollmer, "The Police and Modern Society," Berkeley, 1936, chapter 7, "Personnel."

[2] "Rules and Regulations for the Government of the Police Department of the City of Boston," City of Boston Printing Department, 1927, 115–116, 120. It is significant that this is the latest edition of this manual.

quently jump to the conclusion that "all policemen are like that," forgetting the numerous occasions on which they have been treated courteously by policemen.

There is a wide-spread tradition among policemen that the citizen is always trying to "get away with something," that all men would commit crime were it not for fear of the police. The policeman speaks and thinks of himself as "The Law," "The Force," and he quickly adopts the clichés of his calling, such as "Tell 'em, don't ask 'em," "Treat 'em rough," "What do you think you're doing and who do you think you are?" "Tell it to the judge!" He agrees with what Grover Whalen is alleged to have said, "There's plenty of law in the end of the nightstick"; he beats 'em up and shoots to kill and goes out to revenge the death of his buddies. He adopts the theory that crime is war. It is an open question whether the "war on crime" attitude is ever a sound policy except in the figurative sense in which we speak of the war on tuberculosis or ignorance. Hopkins well says, "Crime is not war. . . . (it) is more akin to a disease in the blood."[3] The result of this antagonistic, militant attitude, this suspicious, domineering, harsh, discourteous, hard-boiled appeal to fear and force, is that the public tends to regard the policeman as an exhibitionistic bully; a stupid, inefficient coward who is never around when you need him; a grafter and political henchman in collusion with crooks; a "railroader" and "framer" of innocent men; an indiscriminate arrester; an inflicter of the third degree; a blustering threatener, over-impressed by his own importance; a disgrace to the law he is sworn to enforce. Needless to say, this is a caricature of the ordinary policeman on the beat, but it is the "picture of him in the heads" of many law-abiding citizens. It is one of those stereotyped, categorical myths which abound in our culture. While it may be untrue, it still is a social reality which must be reckoned with so long as numbers of people believe it.

There is, of course, some basis for this public ill repute of the police. Third degree methods do exist, though they are much less prevalent than is generally believed. False arrest, raids and drives, accompanied by brutality, destruction of furniture and illegal confinement in filthy, crowded jails for days and even weeks is the lot of thousands of Americans. In Dallas, 1,823 people were so arrested in the first three months of 1930 and were incarcerated for a total of more than 40,000 hours. Less than a third of them ever were charged and the convictions were almost nil. Few police departments are guiltless of similar conduct. Buffalo is notorious for the number of "confessions" obtained, and in Seattle, prisoners are frequently beaten brutally at the time of arrest in accordance with the slogan, "Nobody ever licked a Seattle cop."[4] Our policemen are looked upon by many as formidable fellows, armed to the teeth with blackjack and gun, who have a simple black and white morality which divides all people into two classes, good people and crooks, the former being those who give the police no trouble and stand in awe of "The Law" as symbolized by the officer. To this should be added the belief that they use "stool pigeons," threaten the suspect and assume his guilt, and exhibit a general attitude of intimidation rather than cooperation.

There is no doubt that the wide-spread

[3] E. J. Hopkins, "Our Lawless Police," New York, 1931, 322, also chapter 22, "Police Tradition and Mentality." See also, Howard McLellen, *Harper's Magazine*, January, 1936, 236–244.

[4] See Z. Chafee, Jr., W. H. Pollak and C. S. Stern, "Lawlessness in Law Enforcement," Vol. 11 of the National Commission on Law Observance and Enforcement, Washington, D. C., 1931; E. H. Lavine, "The Third Degree," New York, 1930; E. J. Hopkins, "Our Lawless Police," New York, 1931.

public feeling that all policemen are grafters, can be "fixed," are dominated by corrupt politicians and are generally in collusion with crooks, is highly exaggerated and unjust. Most policemen, like the rest of us, are honest, law-abiding citizens. Very few ordinary policemen ever have participated personally in the third degree, very few have ever taken a bribe; most of them are simple, underpaid, overworked and poorly appreciated men. However, because the third degree is used and because some policemen have been found in collusion with crooks and corrupt politicians, the public has formed its unfair, categorical stereotype that all policemen are grafters. For example, of 294 men leaving the Los Angeles' department in one year, 115 were discharged for the following reasons: extortion, stealing (one stole a revolver), neglect of duty, absence without leave, unbecoming conduct, suspicion of murder, grand larceny, rape and other felonies, wanted by police in other cities, intoxication on duty and other offenses.[5] While this may be an exceptionally bad record, enough similar data are known to the public to reinforce the feeling that the police are corrupt.

That policemen are neither very intelligent nor well educated is painfully apparent. The Army Alpha is one of the best standardized intelligence tests. A perfect score is 212 points; those making 135 to 212 are graded A; 105 to 134, B; 75 to 104, C+; and so on. Some years ago, August Vollmer said 75 points on the Army Alpha was the lowest limit for policemen. Such a low C+ (45–74 being C, or average) would have excluded 58 per cent. of Kansas City's force, 55 per cent. of Cleveland's and 43 per cent. of Los Angeles'.[6] Recently, it has been shown in Detroit, after nearly fifteen years of experimentation, that the best single indicator of success as a policeman, and the simplest and cheapest to administer, is the Army Alpha. Detroit now requires 100 points minimum for admission to the force.[7] Mr. Amsden, Los Angeles civil service examiner, has said, "We know from experience that unless a candidate can make a score of 120 in any one of the Alpha tests, it is useless to appoint him as a patrolman." This means that at least 75 per cent. of the policemen in the country are mentally unfit for their work. About 25 per cent. of the policemen in Los Angeles, Minneapolis, Kansas City and Cleveland get A and B ratings, while 91 per cent. of the University of California *freshmen* are in this category. The freshman had 60 per cent. A-men, while the four cities in order had 9, 7, 5 and 4 per cent. A-men.[8] In Chicago in 1931, 4,000 men were finally selected out of 22,000 applicants; 250 were recruited from the top of this list of 4,000; 215 of them got 150 points or less out of a possible 212 on the Army Alpha.[9]

If we look at education, conditions are just as bad. Somewhere around 60 per cent. have only a grade-school education. In Boston, which has one of the best police systems, of 656 added to the force, 1924–27, there were fewer than a dozen high-school graduates, 6 had attended college but none had graduated, over 300 had only an elementary school education

[5] D. G. Monroe and E. W. Garrett, "Report on Police," National Commission on Law Observance and Enforcement, Washington, D. C., Vol. 14, 61; V. D. Key, Jr., *Amer. Jour. Sociol.*, March, 1935, 624–636.

[6] L. G. O'Rourke, *Annals*, November, 19–29, 148.

[7] J. R. Searles and J. M. Leonard, "Experiments in the Mental Testing of Detroit Policemen," Detroit Bureau of Government Research, Report 141, 54 pp., November, 1936. In the first tests, patrolmen received higher scores than lieutenants (71 and 57); this was also true in the Cleveland Survey. The present explanation is that patrolmen have had more schooling than the officers and there is a correlation between test performance and amount of schooling, *i.e.*, the Army Alpha tests other factors as well as "native intelligence."

[8] Monroe and Garrett, *op. cit.*, 58–61.

[9] Bruce Smith, "Chicago Police Problems," New York Institute of Public Adminstration, 1934, 20–21.

and the remainder had spent some time in high schools, business schools, continuation schools and the like, probably until they passed the compulsory school age. Of 659 hired, 322, in order of frequency, had been truckers (80), chauffeurs (68), mechanics, laborers, clerks, taxi drivers, teamsters, metal workers, salesman, shipping clerks (15) and 119 other occupations.[10]

It is possible that these conditions have changed somewhat since 1924–1927. If more high-school graduates have been recruited, there would be a corresponding improvement in Army Alpha performance, both because ability to finish high school requires at least average intelligence and because finishing high school insures a better test performance. However, since the great majority of men on police forces have been there for some time, it is safe to say that both intelligence and education are still far too low to make possible any very high level of police work.

What do policemen read? To what extent do they keep up to date on modern police problems and professional innovations? Little is known about this, but from the above analysis, it is evident that neither by education nor intelligence can much be expected from the vast majority. Neither is there much encouragement for them to study. If one examines the current police journals he will agree, I think, with Donald Young's conclusions in 1929 that the general attitude of police journals is punitive and recreational rather than scientific and professional. Most American police journals would contribute but little to making policemen socially intelligent and technically efficient, even if they were read and understood.[11] How many policemen are familiar with modern criminological and penological theories and findings? How many have read and understood the ordinances of their city and the criminal statutes of their state? How many know anything about modern studies of juvenile delinquency and crime prevention? To the average man on the beat this is an unknown world. If he happens to hear vague references to it, his response is generally contemptuous—criminal coddlers, theorists, reformers, meddlers, sentimentalists, old maids, "professors."

In view of these facts, one is inclined to put some credence in Vollmer's statement that estimated efficiency of the police is about 10 per cent.[12] However, as Vollmer well shows, there is another side to the question. Under present conditions, the police have an almost impossible assignment. The marvel is not that they do their job so badly, but that they do it as well as they do. Poorly selected, ignorant, unintelligent, poorly trained, poorly equipped, poorly paid, poorly led, overworked, the butt of public mirth and condemnation, harassed by crooked politicians, they see a large percentage of the criminals they catch freed by shyster "criminal" lawyers, politician-judges, an antiquated, complicated and inefficient judicial system or by unscientific parole boards.[13] They are called upon to enforce a thousand silly laws passed by socially ignorant legislators; they are blamed for the failure of the church, the home and the school to rear normal, socially adjusted children; they have to make people drive 40 miles an hour while the state builds roads and permits manufacturers to build cars that call for 80 miles an hour—and the police are blamed

[10] Monroe and Garrett, *op. cit.*, 58; L. V. Harrison, "Police Administration in Boston," 1934, Appendix, 192–194 (occupations), 196–197 (education).

[11] Donald Young, *Annals*, November, 1929, 128–134.

[12] "The Police and Modern Society," Berkeley, 1936, 4.

[13] This should not be taken as agreement with the current wide-spread criticism of parole; rather it is a recognition that parole can be and must be vastly improved. It is an indispensable part of a sound penal system. See Herbert H. Lehman, *Survey-Graphic*, February, 1938, 68–72.

for the resulting deaths and injuries; they are called upon to club strikers, to enforce blanket labor-dispute injunctions and to interfere with freedom of speech; they are ordered to stop people from gambling, swearing, spitting, smoking, drinking and even from making love. If they are stupid and short tempered and unreasonable, there are plenty of so-called good citizens who are worse. Vollmer has well said:

> "The citizen expects police officers to have the wisdom of Solomon, the courage of David, the strength of Samson, the patience of Job, the leadership of Moses, the kindness of the Good Samaritan, the strategical training of Alexander, the faith of Daniel, the diplomacy of Lincoln, the tolerance of the Carpenter of Nazareth, and, finally, an intimate knowledge of every branch of the natural, biological and social sciences. If he had all these, he *might* be a good policeman!"[14]

We can sum up the whole matter by saying there are two main reasons why the police experience such difficulty in doing their work: (1) the kind of people they are and (2), the kind of people we are. That is, the police organization is inadequate for the kind of society which has developed in America. It is evident that the "crime problem" can not be solved merely by improving the police. To solve it, we shall have to improve the legal and judicial systems, the political organization, the economic, educational, recreational, familial—in short, the entire social system. Here, however, we are concerned primarily with the police. It is increasingly obvious that present police organization leaves much to be desired. Stool pigeons, fear and force, the third degree, raids, drives and "treat 'em rough" tactics will not work. What should be done?

The answer is simple; the achievement is difficult. Several things are indicated: (1) proper personnel, including leadership, selection, training, pay, promotion and retirement; (2) proper equipment—the police must be better equipped than the criminal; (3) freedom from politics, especially for the executives; (4) centralization and coordination; all police work outside of cities 25,000 and over should be in the hands of the state police, with close cooperation between municipal and state systems; (5) registration of all citizens and rigid control of firearms. The police should be able to account for all persons and all firearms at all times. It should require a lot of red-tape to buy and possess a gun. Any one "losing" or illegally selling a gun should never be allowed to possess another.

What I am saying is simply that police work must become a recognized profession of high social status and decent economic security. When you have a man risking his life every day, endangering his health in all kinds of weather and being held in contempt by the community, all for $125 a month, you can not expect very much. That so few policemen are grafters is good proof of mankind's fundamental morality. That so few of them leave the force is probably an indication of their low quality. They are probably paid as much as they could get in any other line of work. Civil service gives security, even though many students of it assert that it produces mediocrity and apathy in public service.[15]

A policeman should be a college man of superior mental and physical endowment. These are some of the qualities he should possess, according to Harrison:

> There are few vocations which, if adequately performed, require so much of a man—physical courage, tact, disciplined temper, good judg-

[14] *Op cit.*, 222. For some of the sociological backgrounds of conditions discussed in this paragraph, see my "Cultural Integration and Conflict," *Amer. Jour. Sociol.*, January, 1939, pp. 499–509.

[15] W. C. Beyer and Helen C. Toerring, *Annals*, November, 1929, 135–146. Turnover, around 4 per cent. (p. 145) per year. It is a lifetime job. Modal pay, $2,000–3,000 for patrolmen, but 38 of the 78 cities had maximum salaries under $2,000 in 1927–28.

ment, alertness of observation, and specialized knowledge of law and procedure. . . . If he is confronted by a dangerous situation which persons of caution would be inclined to avoid, it is his duty to enter into the thick of it. It may be a family row, a street fight, the pursuit of a desperate criminal, investigation of a burglary alarm, or a serious accident. An alarm is the policeman's cue to go into action. That he is hired to assume these burdens does not detract from the superior qualities which he is called upon to display. He must keep a cool head and take decisive action when trouble arises.

Not only physical courage but strong moral fiber is required of the policeman. He is at war with thieves, fences, and sharpers of every sort who will stop at nothing to avoid interference by police. These underworld characters are skilled in every form of trickery and deception needed to compromise a weak policeman. Gamblers, prostitutes, narcotic peddlers, and bootleggers are ever on the alert to tempt him. They do not always resort to the cruder forms of bribery, for they have gained high skill in employing subterfuges and in devising ways to bring the unwary officer under obligation.

But physical courage and moral stamina are not enough. A policeman may be courageous in the face of danger, or have strong defenses against corrupting influence, and yet be too indolent or too ignorant to perform many kinds of work which make no demands on his more admirable qualities. Moreover, tact and resourcefulness are not often balanced with decisiveness in any person's makeup. Yet tact is a cardinal requirement in the policeman. The handling of quarrelsome or difficult persons, delinquent children, and handicapped defectives of every sort demands sympathetic understanding and abundant common sense.

All of these qualities must be fused in each policeman.[16]

He should take a general course in professional police work. When he graduates, he should be eligible for a position on any state or municipal force in the United States. If he passes the examinations of the local force, he should then have an intensive training in the local police school which should bear the same relation to his college course as an interneship bears to a general medical course. During this year or two, he should learn the local police problems, acquire the morale of the force, gain experience under the direction of the older men, and then, if the executives are satisfied that he has become a competent officer, he should be given permanent status. Another possibility is for the state and municipal police departments to select promising high-school graduates and pay part or all of their expenses at some first-class police college with the understanding that they shall return for their interneship and serve at least three years. The point is that police departments should do their own recruiting rather than rely upon random applications.

Promotion should depend upon achievement as determined by a merit rating system. Nothing is worse than promotion by mere seniority or pen-and-paper examinations, except selection and promotion by "pull" and politics. Needless to say, the executive, the chief or superintendent, should have secure tenure. "Police morale is built on a foundation of honest, intelligent and continuous leadership. No single factor has contributed so greatly to police demoralization as has the practice of limiting the tenure of department heads."[17]

This discussion is not primarily concerned with the training of policemen. It is obvious that a considerable degree of specialization is necessary. This is a technical matter. We are convinced that the police profession must have a personnel as intelligent and well educated as any other profession. This applies to the man on the beat as well as the detectives, traffic officers, radio experts, laboratory men and executive officers. It is from the great rank and file that many of these specialists should be recruited. In any case, the man on the beat largely determines the success or failure of the police service.

We shall assume a patrolman who is a

[16] Leonard V. Harrison, "Police Administration in Boston," Cambridge, 1934, 28–29.

[17] Monroe and Garrett, *op. cit.*, 32. See all of chapters 1 and 2, "The Executive." See also, Andrew J. Kavanaugh, *Police "13–13,"* November, 1934, 5–6, 28.

mentally and physically superior man, emotionally mature and well-balanced, of good commonsense, of college education, technically and professionally trained. We assume that he is part of a centralized, coordinated police system, starting at about age 25, around $2,400 per year, with regular increases up to $3,600, with promotion dependent upon ability shown in service, to be retired at 50 on a livable pension, unless he has achieved an executive position, in which case he might continue to age 65. What should he do and how should he do it?

In the first place, most of the foot-beats should be abolished. A good policeman is too valuable a man to waste his time pounding pavements. His work should be done with his head, not his feet. In these days of machinery, the old-fashioned beat has largely lost its meaning, yet, in a progressive city like Boston, many of the routes have remained unchanged for thirty years.[18] An exception would have to be made for certain densely populated areas. The man on foot is probably a necessity here, but the box system and regularly covered beat should be abolished. It is essential that the crook shall not know exactly where the policeman is at any given time.

It is highly desirable that the policeman should have a definite territory for which he is permanently responsible. Thus, he can establish relations of mutual respect between himself and the citizens. He can know everybody, the particular police problems that exist, and can develop a preventive as well as protective program. When a new man is assigned, the one leaving the beat should work with him until the new man has become thoroughly familiar with the beat. It is quite unnecessary and undesirable to have the patrolman calling headquarters at stated intervals and to be at certain places at certain times. A flash signal recall system will take care of those emergencies when headquarters must communicate with the officer, and a motorized auxiliary reserve would greatly diminish, if not eliminate, most such emergencies. The officer should be able to call headquarters whenever he needs to, but not at stated intervals from stated places.

For less densely populated areas, the patrolman should be given a larger area with a radio car to cover it. The booth system should replace the present too numerous precinct station houses. The New Haven Survey shows how motorization and reduction of station houses would save that city a quarter of a million a year (one third of the total police cost) and would give much better service. According to Monroe and Garrett, only two cities of more than 300,000 have proper equipment. It is much worse in smaller cities and infinitely worse in rural areas.[19] Long ago, Fosdick pointed out that the only change in the patrol system was the reduction from two men to one man on the beat. He recommended the booth system, motorization and two men. Certainly, since the New Haven Survey showed 80 per cent. of the crimes were committed during the two night shifts, two night men, in addition to radio cruiser cars in certain areas, seem indicated.[20] Furthermore, if the patrolman is a professional man, he should be given wide latitude in the performance of his duties. Changing him

[18] J. A. Greening, "Report of Committee on Scientific Standards in Police Service," Yearbook of I.A.C.P., 1936–37, 57–75 (65–67 for discussion of beats); see also L. V. Harrison, "Police Administration in Boston," 1934, chapter 5, "Patrol, Station Houses. Auxiliary Reserves"; Bruce Smith, *Annals*, November, 1929, 1–27.

[19] "Police Department Survey," New Haven, Conn., 1934, New Haven Taxpayers, Inc., 37 mimeograph pages. See L. V. Harrison, *op. cit.*, 100–103, for discussion of equipment, patrols, etc. Monroe and Garrett, *op. cit.*, page 5 and chapter 6.

[20] R. B. Fosdick, "American Police Systems," New York, 1920, 307–310, and "New Haven Survey," cited above.

from beat to beat for fear he will get too friendly with the people, or because some beats are more difficult or dangerous than others is an insult to a capable man. To require him to report every half hour for fear he will go to sleep or loaf is also an insult and makes skilful and constructive work almost impossible. As Monroe and Garrett well say, "Where the policeman does just what he is told and no more, there will be found police inefficiency."[21]

One of the crying needs in police work is to remove the public antagonism to the police which was described and explained at the beginning of this paper. The first step is the renovation of the force. The second is a long period of service in each area so that people, particularly children and young people, may become personally acquainted with the patrolmen and look upon them as their best friends. Cahalane devotes a whole chapter to relations with children, and Vollmer has treated it also.[22] The policeman must not be a bugaboo; he must explain things to children, make friends with them, help them and gain their confidence and respect. This takes time. By the very nature of his calling, the policeman is legislator, judge and jury; he must be social worker and teacher, symbol and embodiment of law and order, of civic consciousness and conscience. He is dealing with all aspects of the most delicate human relations. He is social therapist as well as preventer of social misbehavior. He must become the hero of the children, their companion, counselor and friend. It is no job for a bully and ignoramus. This kind of work can not be covered by police regulations or orders from headquarters. It is a professional task, a science and an art.

The policeman on a beat should not carry a gun or a club. This will not seem so shocking if we remember the recommendation above that a close check should be kept on all guns in the community. We of course should not disarm the policeman until the criminal has been disarmed as completely as is possible. Those policemen who are definitely assigned to capture known desperadoes and habitual, dangerous criminals should be thoroughly armed. The ordinary patrolman has little to do with such matters. It is hard to eradicate from the minds of children the idea of a policeman who "can shoot you or club you," so long as officers go about armed to the teeth looking for some one to shout at or "run in."

The idea that police work consists primarily in catching criminals and frightening people so they will not commit crime is a most serious misconception, both on the part of the police and the public. It is largely responsible for the failure of the police. Fosdick has said that Europeans like and respect the police.[23] Here, we dislike them and do not respect them. This can be remedied only by a reformation of the police and a corresponding change in public opinion. The policeman must first achieve a fundamental respect for himself and the public. Then the public will respect the police. O. W. Wilson has well expressed this: "The essence of a proper police attitude is willingness to serve. We must not confuse servility and service, nor courtesy and softness. . . . We must be firm, but at the same time, courteous. We must avoid an appearance of rudeness." He goes on to say that good public relations can not come from mere propaganda—to "sell the police to the public is selling it down the river!" The police must commend itself to the public by serving it well; informing it through publications, by speakers, by activity in citizen groups, by displays, by inviting public inspection. The appearance and

[21] *Op. cit.*, 27.

[22] C. F. Cahalane, "The Policeman," New York, 1923, chapter 13; Vollmer, *op. cit.*, 189 ff. and chapter 7.

[23] R. B. Fosdick, "European Police Systems," New York, 1915, 234–236.

presence of policemen, the advice and instructions which they give to business men, the welcome and assistance they give to newcomers in the community, visits to homes, work on playgrounds, at schools, recreational centers and parks—these and many other services will commend the police to the public.[24]

Most Americans are not criminals nor potential criminals. Most of them are men of good will and good citizens. Most police work is regulatory, advisory, directive. The sooner we develop a conception of police work in harmony with these facts, the sooner we will be on the right road toward the curbing of crime in so far as police work can do it. The policeman should conceive himself as an intelligent social worker, as a preventer of crime, not as catcher of criminals; as a community servant, not a watch dog and symbol of fear; he should think of his calling as one of the learned professions, of himself as an expert in the adjustment of delicate and complex human relations. In short, his work is an art dependent upon thorough familiarity with the rapidly developing social sciences.

Able police forces, properly trained, properly equipped and wisely led, organized according to principles now known, could do a great deal to control crime. They could catch and convict more criminals, to be sure, but they could do still more to control crime by preventing it through intelligent police work, especially with children and young people. Intelligent police leaders and informed citizens are becoming conscious of these simple facts. A new day is dawning in the whole area of crime control. In the future, we shall pay more for our police services, but we shall get vastly more for our money. In the long run, it will be one of the most productive forms of social investment.

Then, instead of contempt and fear, children and adults will have respect and admiration for the policeman on the beat; then we shall equal and surpass our European neighbors in the handling of crime. We shall demonstrate that a democracy can keep its communal house in order without departing from the fundamental principles of democracy—a maximum of freedom with a minimum of restraint, a fundamental respect for the dignity, personal rights and privileges of the ordinary citizen. Scientifically organized police systems manned by truly professional police officers, and especially by socially intelligent, professional policemen on the beat are powerful and indispensable prerequisites for the realization of this democratic ideal to which all good Americans must give their undivided loyalty. Within reasonable limits, we can solve all our social problems. The problem of crime is no exception.

[24] O. W. Wilson, "The Police and the Public," Yearbook of the I.A.C.P., 1936–37, 46–55, especially 47–48. See also, Cahalane, *op. cit.*, 8–11; A. Wood, *op. cit.*, entire book; Vollmer, *op. cit.*, chapter 7.

GREAT LANDED ESTATES IN THE MEDITERRANEAN REGION

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Introduction

Land is a fundamental resource, and, together with climate, it has been the object of intensive study. But we should not too readily conclude that the number of people in a given region and their activities depend solely upon the qualities of the soil and climate. There is another very significant factor which has all too often been only very briefly considered or overlooked entirely, and that is, who owns the land. For example, Mexico is spoken of as a beggar nation sitting on a pot of gold largely because of the concentration of land in the hands of a few families. Abject misery for millions of peons has been the result. The entire history of the southern states of the United States differs markedly from that of the northern states, less because of differences in soil and climate than because of the growth of the plantation system before the Civil War and the development of the institution of share-cropping since that time. In Denmark it has been the policy of the Government to distribute land as equitably as possible, in accordance with the principle that "very few should have more than they need and fewer still should have less than they need." As a result of this policy Denmark has become a country of prosperous small landholders, one of the richest agricultural nations of the world. Denmark has about the same soil and climate as East Prussia, yet the latter is rather sparsely populated by poor peasants because the land is concentrated in the hands of a few powerful Junker families. These marked differences in development between Denmark and East Prussia are due rather to the different systems of land tenure rather than to differences in soil, climate or race of people.

Great Estates Common in Mediterranean Basin

Large landholdings are an important factor in the Mediterranean region. Sometimes they are of feudal origin; others have resulted from the encroachment of great landlords upon either small individual or large communal holdings; still others are huge grants awarded to some successful military leader. In the Balkans the victorious Turkish chieftains appropriated great blocks of land, or "tchifliks," often merely ousting the Christian landlords. In Syria large estates are the rule, especially in the cereal country east of the coast ranges. In Algeria after the French conquest huge concessions were made to companies and to individuals, particularly during the Second Empire. Great landholdings, or "latifundios," are quite wide-spread in Spain, while in Sicily 1,400 estates comprise 30 per cent. of the total area of the island. Great holdings are prevalent in Italy, both in the Po Plain, where intensive agriculture obtains, and in the extensively farmed regions of southern Italy. Even in the French Midi large estates (over 10 hectares) are becoming general, taking up from 35 per cent. of the cultivated land in the eastern Pyrenees to 50 per cent. in l'Aude.

Unfortunately, great landholders are not, as a rule, convinced that *noblesse oblige*. Their estates are simply farmed extensively under the supervision of a resident manager, and, the owners being assured of ample income without risk and without effort, they make no attempt to increase production and thereby raise the standard of living of the miserable peasant. This has been true from one end of the Mediterranean to the other. It is easy to blame the climate or the "Latin

temperament" for the growth of brigandage, the vendetta or the maffia, depending on the region, instead of unemployment, very low wages and the consequent miserable living conditions for which bad harvests and the greediness of usurers have been largely responsible.

Some Advantages of Great Landed Estates

Centuries of experience have taught the Mediterranean peoples that landholdings below a certain size are not stable in regions where harvests are likely to be uncertain because of droughts. Methods similar to those employed in modern *dry farming* were mentioned by Homer, Xenophon, Theophrastus and Virgil. Because of the immense amount of hand labor required before the advent of modern methods of mechanized agriculture, especially when cereals were the main crop, slavery was in vogue during ancient times, serfdom during the Middle Ages. By the fourth century, B.C., in the city-state of Athens, small landholdings were gradually acquired by rich money-lenders till large holdings were the rule. The history of European colonization in North Africa has conclusively proved that in those areas best adapted to the extensive production of cereals only large-scale holdings can survive. It is easy to draw parallels between such areas and our great wheat-producing states. North Africa might well be cited as an obpject-lesson to those who look with misgivings upon the development of vast machine-cultivated holdings in the Spring Wheat Belt of the United States. The rainfall, at all events, is independent of political systems, so, although 160 acres may support in comfortable circumstances one family—or even two—in the Corn Belt, the same is not true in the Wheat Belt—no matter how much wishful thinking be done.

Large Landholdings in Apulia

In southern Italy in the province of Apulia there are many great landed estates on which most of the work is done by day laborers. Here agriculture has the characteristics of the industrial undertaking for two reasons: (1) The amount of precipitation varies greatly from year to year, causing great fluctuations in total annual crop yields. Large estates can survive such uncertain conditions better than small holdings, (2) The agricultural products are for the most part not consumed locally; hence, they are subject to the vagaries of distant markets. Here again the margin of safety is not great enough for the small peasant.

Latifundios in Spain

The present system of land tenure in Spain dates largely from the time when the industrious Moors were expelled. Their land was confiscated and parcelled out in immense estates to the Catholic Church, to noble families and to army officers of high rank. The estates were really feudal fiefs, and the people living on them became serfs, attached to the estate. And as a result of the law of primogeniture, many of these estates have remained almost intact even to the present day, after more than 400 years.

In the course of centuries the great estate became a business enterprise on which a certain income was to be realized annually. Naturally the owner would prefer extensive cultivation of a crop that could be planted and harvested without high labor costs. No attention was paid to the needs of the people or to diversification of crops. One-crop farming was the rule. Formerly it was believed that latifundios represented only agglomerations of poor land. Surveys have shown this belief to be untenable. The province of Alicante has almost twice the population to the square kilometer (96) of the province of Seville (56). Both are equally fertile, but Seville is to a large extent in great landed estates. In Valencia, where small landholders prevail, the value of the yield of cultivated land averages 985 pesetas annually,

whereas in the rich province of Seville, with its latifundios, the annual average is only 401 pesetas—less than half as much.

And now some statistics with regard to the extent of concentration of land in the hands of a few. Spain's three greatest landowners, the former archdukes of Medina, Peñoranda and Alba, control more than 420,000 acres, and the next five largest holders control more than 145,000 acres. Thus the eight largest landowners control more than 465,000 acres of the best farm lands in Spain. Twelve hundred families own more than 40 per cent. of all the agricultural land in the country, and another 20 per cent. is owned by 75,000 families. If this same condition existed in the United States it would mean that approximately 7,500 immensely wealthy families would own almost one half the land of our country. And now I wish to show how this concentration of cultivable land in Spain in the hands of so few people has resulted in a terribly low standard of living for millions of peasants.

The great latifundios require few workers and then only at certain seasons. A limited range of crops gives rise to great seasonal fluctuation in employment. High wage rates may exist for the rush season, but the wage in no wise suffices to carry over a family to the next peak season. For this limited economy the owners of the immense estates have been to a large measure responsible, and only under the Republic, after decades of social trouble and anarchy, have serious attempts been made to seek greater range of crops.

An added exasperation is that the seasonal demand may require importation of labor from far provinces, which gives rise to the anomaly that, in an area noted for rural unemployment, migrant labor must be called in. The three crops of Andalusia—cereals, olives and vines—give some spread of labor; but in Castile wheat and barley are the only crops, and even these vary enormously in yield according to the variations of rainfall. The plight of the rural laborer is pitiable in the extreme.

The English geographer, Mr. Dobby, in an article on "Agrarian Problems in Spain" in the April, 1936, issue of the *Geographical Review*, gives a graphic picture of the distress of the laborers and the attitude of the landowners. I quote, "I recall an incident during a visit to an experimental pig farm in an out-of-the-way part of Andalusia. From the darkness at one end of the building came a red glow. I went along and found a laborer's family crouched on the floor round a twig fire with smoke so thick that breathing was difficult. The malodorous squalor contrasted with the carefully washed pig pens that I had been seeing. To my query an old woman mumbled: 'Yes, we live here. Worse than the pigs.' At which the owner beside me exclaimed indignantly: 'You have a roof over your head. What more do you want?'"

The consequences of the great landed estates have been: depopulation of the countryside, inefficient methods of farming, very low average wages, high rents, scarcity of live stock and a generally precarious economic situation for about a third of the country. In whole regions, as a result of a too rainy or a too dry season, a windstorm or a bumper crop with a consequent sharp drop in prices, the entire population may be reduced to the verge of starvation. Small wonder then that the people of this vast rural slum of Andalusia have for a half a century been ready to follow any political party—anarchosyndicalist or socialist—that has promised speedy and sweeping agrarian reform.

One of the first acts of the new government, when the Republic was established in 1931, was to write the law of agrarian reform—formulated in September, 1932. The law defined the properties liable to expropriation, established cooperative societies and encouraged agri-

cultural instruction. The breaking up of the estates was begun in 1932. Although the great landlords concerned, only 25,000 in the entire country, were to be paid off gradually in the course of a generation, they at once became bitterly hostile to the new government. The church property, valued at $500,000,000, was nationalized in 1933. This act served to make the Catholic Church implacably hostile to the new régime.

But most of rural Spain still seethed with misery, and at last in February, 1936, general elections were held. The result was an overwhelming victory for the left Republicans and the workers' parties. With this tremendous showing of popular support of the new government felt justified in going ahead with land reforms. One of the first decrees of the Azaña Government was that of February, 1936, which stopped payment of all indemnities which the preceding Right Government had granted the great landlords for their expropriated estates. In the first days of March, 1936, rural workers and tenant farmers returned to the lands allotted them by the first agrarian reform, which were taken away from them during the Right reaction of 1934–1935. Thus the Institute for Agrarian Reform noted that within a single week it had "installed" on the lands at its disposal 17,114 families of rural workers or tenant farmers. As a matter of fact these people installed themselves on the plots originally granted them which were subsequently taken away.

The large landholders were no longer allowed to continue keeping valuable land uncultivated. Much excellent land, for example, had been withdrawn from cultivation in the Guadalquivir Valley to be used as pasture land for the bulls destined to be killed in the bull fights. The new law made it compulsory to rent this land to the starving peasantry.

The breaking up of the great landed estates and the nationalization of the property of the Roman Catholic Church made the two most powerful elements in Spain deeply hostile to a government duly elected by a huge majority. The landlords and the clergy were willing to do anything to overthrow the government, even to the calling in of foreign mercenaries. But it is hard to see how a government can be stable if foreign troops are necessary to impose it on an unwilling people.

The system of slavery formed the material basis on which a flourishing culture was developed by the ancients, but once the iron grip of Rome was loosened the ancient world was precipitated into definite ruin, and the Dark Ages intervened before another culture could come into being. "In speaking of Mediterranean civilizations it is necessary to distinguish, on the one hand, that which constitutes for them a durable, ever-valid basis from that which, on the other hand, has not been, in the history of human societies, but a unique and transitory success, the glamor of which should not mask the inherent defect."[1] Franco's régime, once installed, may be a transitory success, but the inherent defect is that it will have been imposed by outside force. The land problem must either be solved or the population subjected to a modern Inquisition.

Conclusion

By way of conclusion allow me to quote the concluding sentences of my review of Pascual Carrion's great work on latifundios in Spain. This review was published in the April, 1936, issue of the *Geographical Review*. I quote: "All other problems in Spain fade into insignificance beside this one of agrarian reform. According as it is or is not satisfactorily solved, millions of people either will achieve a standard of living to which human beings are justified in aspiring or will continue to vegetate in illiteracy, misery, and squalor."

[1] Charles Parain, "La Mediterranee, Les Hommes et Leurs Travaux," p. 209. Librairie Gallimard Paris, 1936.

CULTURE AND CIVILIZATION IN GUATEMALAN SOCIETIES

By SOL TAX

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DR. REDFIELD writes that in Yucatan there is a gradual retreat from the city, as a representative of modern civilization, to the villages in the interior as representatives of folk culture. On a more or less common cultural base, specific and striking gradual changes are seen to occur in space from the villages through the larger towns on the railroad to the city of Merida; and in a general way the differences reflect the changes that have occurred in the course of time. The evidence points to the conclusion that the intermediate "towns" were once culturally akin, in certain respects, to the villages as they are seen to-day, and with the advent of the railroad have been and are being gradually assimilated (in these respects) to the civilization of the city.

The differences between the village and the city, therefore—since they represent the course of cultural change in Yucatan—are especially significant, and Redfield justly sees in them a suggestion of more universal application than to the field of Yucatan alone. He defines the difference between the village and the city in terms of a difference between "culture" and "civilization," and says of it:

> The one type of society, approached in the village, is a relatively immobile society, culturally homogeneous, in which the ways of life form a single web of interrelated meanings. This culture is closely adjusted to its local milieu. Relationships are personal, and the important institutional controls are familial. The sanctions which control conduct are prevailingly sacred, piety is emphasized, and custom has the force of moral rule. Ritual is highly developed, and expresses vividly the wishes and fears of the people. On the other hand, as one leaves the village and moves through the town to the city, one goes toward a contrasting type of society. This society is much more mobile, and culturally heterogeneous. The ways of life are less closely interrelated; group habits exist more in terms each of itself, and do not to the same degree evoke a body of closely associated definatory acts and meanings. These ways of life rest upon, but are not of, their natural environment. Relationships are increasingly impersonal, and formal institutions qualify the acts of the individual. The familial organization is much reduced in importance as an instrument of control. Life is secularized; economic advantage and valuation have penetrated the social body; and the individual acts from constraint or convenience rather than from deep moral conviction. Religious belief and action are much reduced; the individual can no longer express himself in the comfortable grooves of sacred ritual.[1]

Since this was written, the Carnegie Institution has extended its ethnological researches into the highlands of Guatemala, and we have had the opportunity to consider certain towns there in the light of Dr. Redfield's experience in Yucatan. Although the work has by no means progressed to a point comparable with that in Yucatan, certain contrasts in the two regions are demonstrable.

Historical considerations would lead one, offhand, to suppose that the sociological conditions in Yucatan and Guatemala would bear close resemblances. Geographically the two regions are close: the highlands of Guatemala rise practically from the southern edge of the plain of the peninsula of Yucatan (with, however, an almost impassable and uninhabited area between the highlands and the northern part of Yucatan about which Redfield writes). Linguistically, the Indians of both places speak

[1] Robert Redfield, *American Anthropologist*, 36: 68–69, 1934.

languages of the Maya stock, although different branches. Culturally, at the time of the Conquest both regions were certainly part of one culture-area, and even to-day there are many close resemblances of both material and non-material culture. On this common base the same Spanish conquistadores and the same Spanish colonists came in at about the same time; and now each place is subject to about the same influences from the complex civilization abroad.

Yet the fundamental ecological set-up of what Redfield calls the "gradients of civilization" is quite different. The peninsula of Yucatan

> is a single geographic region: a forested limestone plain. The rainfall increases as one goes southeastward until it is so great that human habitation is difficult. Merida, the capital city, is located in the northwest corner of the peninsula. This is the center of contact and of influences political, social, and cultural. From this point the roads and railroads move outward, becoming, in the southeast, trails through the bush. These trails, as one continues to move southeastward, become less frequent and less traveled, until one reaches the isolation of central Quintana Roo, where the Indians are visited only by the chiclero and the occasional traveling merchant.[2]

There is a regression from the characteristic city ways of life in Merida through the intermediate towns as they are farther away on the railroad to the folk ways of the villages off the beaten paths.

To this, the picture in Guatemala bears hardly any resemblance. On an east-west axis, the capital of Guatemala is about in the center of the highlands. Since it is the section most typically Indian (as well as the only one we have so far studied) we need here consider only the highlands to the north and west of the capital, Guatemala City, which is to Guatemala just what Merida is to Yucatan. Since in this region the country is mountainous and irregular, rather than a plain, one might think that the influence of the capital would fall off even more rapidly, as one leaves it, than in Yucatan.

Such a comparison is, however, not fruitful, for conditions are too dissimilar. The gradient of civilization in Guatemala does not at all accompany geographic distances. It happens that in Guatemala the self-perpetuating class of Spanish-speaking non-Indians, called *ladinos*, have become settled in fairly large towns distributed all over the highlands with no relation to distance from the capital. These towns have all the cultural advantages, for the ladinos, and many of the characteristics, of Guatemala City itself. There are good automobile roads to all of them, and daily freight and mail service; newspapers and the material conveniences of life are easily available. Telegraph and telephone lines come to all of them. Each has a quota of large stores visited frequently by the representatives of importers from the capital, and their stocks of goods are kept up to date. Each has its electric light plant, its water system, its printing presses, its library, its schools. The wealthier of the ladinos own automobiles, and travel frequently to the city, where many of them have homes. There is hardly more cultural-lag from the capital to these towns than there is from New York to the cities of our middle-west.

Thus civilization is represented evenly in every section, and what gradient there is is describable from any of these towns, or the capital, to the country back of it or between two of them. In this country there are smaller settlements of ladinos, who are generally a short step behind their fellows of the larger towns in education and material progress; but most of it is populated by Indians, some of whom also live in small towns but who for the most part live on their farms surrounding and between both the smaller and the larger towns. These Indians constitute 90 per cent. of the population;

[2] *Op. cit.*, p. 62.

they are direct descendants—racially, linguistically and culturally—of their pre-Conquest forbears of the region; in every sense they are fairly comparable to the Maya Indians of Yucatan. To the casual observer they appear to be, indeed, more purely Indian, and ostensibly even better representatives of folk-culture than those of the villages described by Dr. Redfield. The fact that they are as close, physically, to civilizational influences almost as the very suburbs of Merida, not to mention the town on the railroad about which Redfield writes, naturally suggests that they may be well on the road to deculturation.

That this suggestion is highly pertinent can be seen from a consideration of how very close the physical contact really is. The Indians are territorially divided into so-called *municipios*, or townships; each of these has a town in which are located the official buildings, the church and the market-place. The Indians take turns being officials—both political and religious—so that all of them, for fewer or more years of their lifetimes, are resident in the town during their terms of office. In addition, the town usually has market one or two days a week, and most of the Indians come in to spend the day. Furthermore, on occasions when there are religious feasts or ceremonies almost all of them come to the town to stay for several days or a week. And finally, all business concerning land and many disputes of whatsoever character bring individuals to town almost any day in the week or year. Now some of the municipios have for their town-centers just those large towns that are populated by urban ladinos. Naturally, in these places the Indians have the closest of contacts with civilization. They see the houses and the clothes of the ladinos, they become acquainted in the stores with the novelties of the outer world, and they see practiced—and hear about—modes of behavior different from their own.

Indians who live in municipios the town-centers of which are *not* inhabited by ladinos do not, of course, have so frequent contacts with civilization. Nevertheless, they are far from isolated. Most of the Indians are inveterate travelers; some are traveling merchants, and they of course spend most of their time in the markets of the larger towns or traveling between them. But even those who are not merchants like to go to as many markets and fiestas as they can, if for nothing more than to see many faces. Men, women and children are habitually "on the go," and in most cases they visit the larger and more important towns—those, again, with the ladinos. Furthermore, Indian officials in the smaller places (and every man is one sooner or later) are obliged to visit the larger towns frequently on official business. Thus on the whole there are few men [though more women and children] who have not seen samples of the material goods or been exposed to the influence and ideology of modern civilization.

Whether or not this contact has had its expected effect—whether or not the Indians have been or are being deculturated—is a question not to be answered directly or conclusively, since it is not possible to view them two or three generations ago. But two points can be made—points significant in the resolution of the problem raised by Dr. Redfield's paper.

The first is that in certain definable respects the Indians represent folk-cultures quite as much as any in Yucatan. They are, indeed, far *more* backward, in literacy, education and a knowledge of what goes on in the world, than the people of the village specifically described by Dr. Redfield. They are as unworldly as the most isolated of primitive peoples. Their methods of agriculture, their food, clothes, utensils and their mode of life, as well as their beliefs concerning nature and the supernatural, bear next to no relation to their proxim-

ity to the influences of civilization. Moreover, they are more like primitive tribes than the Indians of Yucatan. The Indians of each municipio speak a common dialect peculiar to themselves; they have their own particular costume, they disapprove of intermunicipio marriages, they have a name for themselves as a people, they have a strong ethnocentric feeling, they have a distinct political and religious organization, economic specialties and even standards of living that may be peculiar to themselves, and, finally, in their general world-views, beliefs and individual cultural practices they tend strongly to be homogeneous in the municipio on the one hand and, on the other, set apart from the people of other municipios. In these respects the Indians of Guatemala are certainly "folk" as Redfield defines the term.

Why the culture, in these respects, is maintained in the face of apparently adverse conditions is not too difficult to explain. Since the Indians are uneducated, ignorant and unworldly, the newspapers, the telegraph and the telephone, not to mention the ideas entertained by the urbanized ladinos, mean next to nothing to them; and if their contact with these things is physical, it is not actual. The influences do not penetrate; the Indians are exposed, but can not receive. Furthermore, they are on the whole too poor to receive the material advantages of civilization. Radios, even should the Indians understand their usefulness, would be far beyond their reach; indeed, their pocketbooks do not extend even to flashlights, which they do understand. In Yucatan, by way of contrast, the policy of the government has been consciously to educate the Indians, to make them aware of and to want new ideas and things.

Another reason why the Indians need not receive simply because they are exposed is found in the pattern of their culture itself. In contrast to Yucatan, where there is really only one culture, the Indian groups of Guatemala differ from one another in the ways that I have mentioned, and this in the face of continual contacts of individuals of one group with those of another. They are used to seeing differences and to ignoring them. They recognize that "the Indians over there" have this or that custom different from their own, and on the whole, while they are tolerant of it, they do not adopt it. This characteristic, so often in evidence among the Indian groups themselves, is naturally brought into play in their contacts with the ladinos. If the urbanized ladinos are known to think or do in another way, that is their business—quite to be expected—and has nothing to do with the Indians. Thus whatever influence the proximity of civilization might have is effectively nullified.

The second point is that in other respects the Indians of Guatemala, far from resembling Redfield's typical *folk* culture, actually fit the criteria by which a city-type is judged. Indian society, even in one municipio, is relatively mobile; individuals and families shift both their economic positions in the community and the respect in which they are held, with comparative ease and frequency. Relationships are surprisingly impersonal, and familial organization is, if anything, at a lower point in social control than even among us: the formal organization, as represented by the Indian officials in the town hall, and by the elders of the community (a definite and organized group) is resorted to in all manner of dispute even in the primary family. The activities of life—economic, social, political and religious—are in a real sense secularized; individuals in all matters which give them relatively free choice act from thought of personal gain, and the necessities of the community must be filled by forcing individuals to contribute. Religious action on the part of individuals is at a minimum, with specialized communal organizations per-

forming almost all rites that are deemed necessary in common belief. The ideas back of Indian relations and activities themselves in most of their aspects are, as Redfield has analyzed them, city-like and civilized.

Does this mean that in fact the contacts with civilization have had their expected effects after all? Have the Indians—while still illiterate and unworldly—been affected in their social organization and means of social control? Are they, in these important sociological respects, deculturated?

To answer "Yes" would have this important implication: that on the whole, Dr. Redfield's extract of general terms from his Yucatan experience takes on added significance and force, since by even formal contact with outside civilization, groups more primitive even than in Yucatan show the effects of deculturation even without an advance in sophistication.

To answer "No" would have contrary but equally significant implications:

(1) The influence of outside civilization—notwithstanding the close physical contacts—would appear to be extremely small; a study of the reasons might throw much light on the mechanisms by which western civilization *does* influence native tribes.

(2) We should be forced to conclude, in terms of Dr. Redfield's conceptions, that the Guatemalan societies represent neither culture nor civilization, but a combination of both. Further, if the Indian communities are not to be considered simply in transition, we must recognize that a stable society can be small, unsophisticated, homogeneous in beliefs and practices and still be mobile, with relationships impersonal, with formal institutions dictating the acts of individuals, and with familial organization weak, with life secularized, and with individuals acting more from economic or other personal advantage than from any deep conviction or thought of the social good.

It is natural, therefore, that I hesitate to answer, especially since the proof of this kind of assertion must consist more of judgment in the interpretation of facts than of clearcut facts themselves. Yet it appears to me that the answer is "No"—that modern civilization as it is represented in Guatemala City and in the ladino towns of the highlands has almost nothing to do with the apparently un-folk-like character of Indian social organization. I do not assert that that organization is pre-Columbian, for it obviously is not; I do believe, however, that its essential characteristics are not recent innovations, that they are explicable in terms of themselves, that the culture is an integrated and consistent whole the peculiarities of whose social organization are matched by fundamental behavior and cultural patterns existing in the communities.

BOOKS ON SCIENCE FOR LAYMEN

ALCOHOL AND THE INDIVIDUAL[1]

THE problem of unwise indulgence in alcohol is one which seems to have been always present. Unfortunately the approaches in the past have been too largely based on ethical, religious or penal grounds, and none of the approaches seems to have been conspicuous for its success. The statistics of courts and correctional institutions indicate overwhelmingly the futility of dealing with drunkenness as a crime; and the results of the late lamented experiment of prohibition appear to indicate that fiat legislation with regard to alcohol is not a success. That drinking, far from showing a decline, is on the increase, particularly among young people, is shown by some statistics quoted by Strecker and Chambers in the "Introduction" of the present volume, which show an increase of 183 per cent. of rejections by one life insurance company "involving heavy alcoholic indulgence" in the age group under 30 from 1931 to 1936.

The problem of alcohol, then, is still with us, and it is encouraging to find a volume like that by Strecker and Chambers, which describes a reasonable approach to the problem of drinking from the psychiatric point of view. Dr. Strecker is professor of psychiatry at the University of Pennsylvania and one of the very prominent psychiatrists of this country. His co-author, Mr. Chambers, is described in the "Introduction" as one who himself has been an alcoholic and who has not only cured himself but has made a close study of the factors involved in alcoholism and its treatment. The volume points out that the medical value of alcohol is slight, indeed; that it is a narcotic drug, but that by its release of inhibitions it serves a purpose, in the case of those who are able to use it intelligently, as a social lubricant. The vagueness of the term "alcoholism" is stressed, and it is pointed out that drinking to excess may occur in at least twenty-eight separate conditions. Some alcoholics, the authors admit frankly, can not be helped, while on the other hand they recognize such a group as the "normal" drinker. The abnormal drinker is defined as: "The man who cannot face reality without alcohol and whose adequate adjustment to reality is impossible as long as he uses alcohol." (p. 35.)

Under the general heading "The Psychology of Alcoholism" we find such chapters as: "The Identification of the Alcoholic," "Suggested Psychological Mechanisms in Abnormal Drinking," "Alcohol and Sex" and "The Alcoholic Breakdown." The authors point out that the attitude of the general public, "which still tends to regard alcoholism solely as an ethical problem to be cured only by punishment or prayer," hampers materially the helpful approach of the physician to the alcohol problem. They go on to say (pp. 128, 129):

> In a sense, alcoholics are still, too often, as badly treated as were the insane hundreds of years ago, when their symptoms were thought to be due to demoniacal possession. It is true that there is no physical inhumanity, but ignorant and clumsy methods too often destroy the very potential in the alcoholic patient that might have been accessible, had this problem, like the neurotic breakdown, been understood by the public as a problem in abnormal psychology.

As for treatment, three fundamental attitudes of mind are pointed out as necessary for success in dealing with the alcoholic:

> 1. The individual must be convinced *from his own experience* that his drinking is so abnormal (of a quality distinct from normal indulgence) that it constitutes an entirely undesirable and impossible way of living.
>
> 2. He must be absolutely sincere in his desire to learn how to stop drinking *once and for all*, regardless of his opinion of his ability to do so.
>
> 3. He must be willing to make a supreme effort to practice *daily, over a long period of time*, and with as much interest and vigor as he is capable, the methods which have proved

[1] *Alcohol One Man's Meat*— By Edward A. Strecker and Francis T. Chambers, Jr. xvi + 230 pp. $2.50. The Macmillan Company.

to be successful in the elimination of destructive habits. (Pp. 190, 191.)

Following the prerequisite recognition by the patient that he is abnormal, an attempt is made to bring him to a more realistic facing of reality and to the keeping of a definite schedule. Frequent consultations with the psychiatrist are held, and it is estimated that about one hundred hours of such conferences are likely to be necessary for the optimum results. Attention is given not only to re-education, the development of a conditioned reflex with regard to alcohol, and self-understanding on the part of the patient, but also, particularly, to nutrition, exercise and diversion. The authors do not advise institutional care, at least as essential, although it is recognized that in some cases it is preferable. The rules which the authors lay down are principally the following four:

1. An understanding on the part of the patient of the seriousness of the condition, and the development of a desire to take the treatment.
2. There must be abstinence from alcohol during the period of treatment.
3. The patient must be entirely frank and honest in all his dealings with the therapist.
4. In the event of a relapse, the patient must notify the therapist, or see that he is notified as soon as possible. (P. 213.)

The volume is practical, progressive and sound. It represents an unemotional, scientific approach to a problem which is wide-spread in frequency and ramifications. The reading of the volume is recommended to all who have alcoholic friends, and indeed to all intelligent and open-minded citizens.

WINFRED OVERHOLSER
SAINT ELIZABETHS HOSPITAL,
WASHINGTON, D. C.

THE GOLDEN PLOVER AND OTHER BIRDS[1]

THIS profusely illustrated work is the second volume of American bird biographies collected in book form from magazine articles by the author. As is well known, in the series of articles originally appearing in the magazine *Bird Lore*, the author writes as if he were the bird telling its own tale, the whole being done in the first person. These stories have had a deservedly wide appeal in their original form and should continue to serve their large and growing audience in their present collected format. While addressed primarily to school children and amateur bird students, they contain much valuable material, not so much in the way of particular observations as in the summing up of long and intimate experience based on many such observations and are, therefore, of interest to the more advanced student as well. For example, it seems simple enough, in the account of the double-crested cormorant (p. 270) for the bird to say of the related species, the common cormorant, ". . . he hasn't half the sense that I have. He hasn't even learned the meaning of a gun. . . .," but obviously a good deal of observation is here summed up. Similarly, the "bird's-eye view" of the southward migration of the golden plover (pp. 12–13) could not have been written if the author had not had a large experience and consequent insight into "personality" of the species.

The large number of photographs illustrating the text is a notable series of observational facts, even independent of the text. The colored plates (representing golden plover, cardinal, indigo bunting, crested flycatcher, meadowlark, cedar waxwing and red-winged blackbird) are less successful, as the colors have not been well reproduced in some cases (especially the cardinal, indigo bunting and the golden plover chicks) and all have a slightly hazy look that is not an advantage to them. At the end of the book are "Questions on the Life Histories of North American Birds," the answers to which are to be found in the autobiographies. There is no index, but this is hardly a lack in a book of this sort.

H. FRIEDMANN

[1] *The Golden Plover and Other Birds.* By A. A. Allen. Illustrated. xiii + 324 pp. $3.00. Comstock. Second Series.

THE HEAVENS AGAIN[1]

THE great success of the Hayden Planetarium, in New York, and of *The Sky*, its splendid popular magazine, have now been supplemented by a popular book on astronomy by two of its assistant curators. Astronomy remains perennially the science in which there is greatest popular interest, whether measured by amateur societies, attendance at lectures or the publication of popular books. In Pittsburgh alone there are about 100 telescopes that have been constructed and are being used by amateurs, and a number of other cities have comparable records.

As might be expected from its title and the positions of its authors, the book under consideration has been written for the lay public. It contains two chapters on the beginnings of astronomy, general discussion of astronomical instruments and a good popular description of the solar system. The more difficult problems connected with the explorations of the universe beyond the limits of the solar system are discussed more briefly. The book is evidently designed for the intelligent reader who has at the best a limited knowledge of astronomy.

Readers of this book will enjoy its clear and straightforward style and its excellent illustrations, though they are not as abundant as in many other books on popular astronomy. The experienced astronomer will feel perhaps that the authors have not been as cautious as they should have been in reporting speculations about conditions on Venus and Mars, and especially in interpreting the inferences that may be drawn from the theory of relativity about the origin, nature and destiny of the universe.

F. R. MOULTON

CONTROLLING "INDOOR WEATHER"[1]

MR. FULLER has prepared this book on air conditioning for readers who "have not had the advantage of higher mathematical training." The subject is a highly technical one, but the author has presented his material very clearly without using technical phraseology; the book is well fitted to the needs of those young men, without a specialized training in engineering, who are concerned with the selection and operation of equipment used for air conditioning.

The arrangement of the material is good, and every important division of the field is considered. The topics covered and their order are: the properties of air, load calculations, duct design and air distribution, registers and grilles, heating and humidifying, fans, cooling coils and air washers, refrigeration and refrigerating equipment, well water and ice cooling, evaporative condensers and cooling towers, unit coolers, controls, air cleaning and codes and ordinances.

There is an excellent chapter on fans and fan performance that is typical. After studying this clear explanation of the fan laws and characteristics of the combined fan and duct system, the reader is better qualified to select a fan for a given duty. The book will not be widely used as a college text, and there is little material for the designer or for the engineer interested in the thermodynamic processes of air conditioning. As stated in the preface, however, the book is not intended for such readers. The method of presentation is distinctly original, and there are very few references to other books or to articles in technical journals. An interesting innovation is the inclusion of a chapter on codes and ordinances that affect the installation of air-conditioning equipment.

Most of the illustrations were supplied by the manufacturers of air-conditioning and refrigerating apparatus. A copy of the Bulkeley psychrometric chart and a pressure-heat content chart for dichlorodifluoromethane (freon 12) are included.

C. O. MACKEY

[1] *The Story of Astronomy.* By A. Draper and M. Lockwood. Illustrated. xi + 394 pp. $3.00. The Dial Press.

[1] *Air Conditioning.* By C. A. Fuller. Illustrated. ix + 577 pp. $4.00. Henley.

THE PROGRESS OF SCIENCE

SCIENCE AND THE NEW YORK WORLD'S FAIR

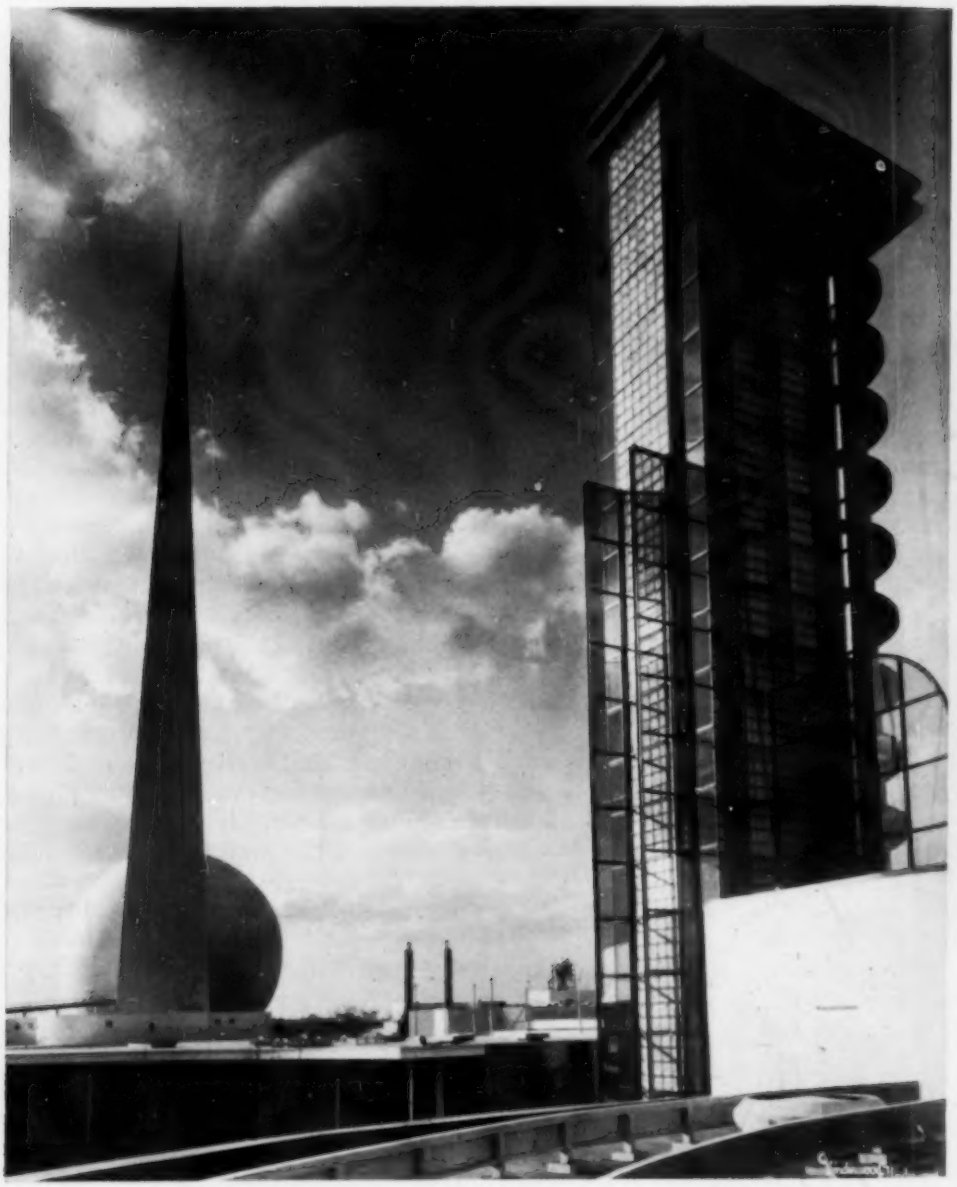
THE presentation of science at the New York World's Fair differs radically from the purpose and method of previous fairs. The theme of the fair, "Building the World of To-morrow," expresses a great social purpose which is subtly effective. It runs through all the design and is never quite hidden in the glamour, excitement and entertainment features. It assumes that all the instruments are at hand for building a better world and that the public, detached from its every-day affairs, can achieve a broad, forward-looking point of view and, through the agency of the fair, become more aware that modernity goes infinitely deeper than the mere use of to-day's devices and gadgets. Revelations in city planning, in art, in social conditions here and abroad and in the content of modern life will be effective. In all this it is recognized that the most important force in making this new world is science.

In accord with this theme, science is presented throughout as a powerful social force. There is no effort to teach the facts or principles of any of the sciences. On the other hand, the responsibility of science in creating our present world is repeatedly stressed, with less emphasis on the economic and industrial applications of science than on the broader social consequences in community life, in the home, in leisure, habits and morals. "Science to-day," said Grover A. Whalen, president of the Fair Corporation, recently, "can not be confined in a museum and is not the concern of specialists only. It is a part of the very air we breathe. As in daily life we meet the effects of science at every turn, so in the fair science will be found in every presentation of what people do, and has its part to play in almost every building on the grounds."

The responsibility for the portrayal of science in accord with this theme has been in the hands of the Advisory Committee under the chairmanship of Professor Albert Einstein, including such eminent scientists as Dr. Frank B. Jewett, president of the Bell Telephone Laboratories, Mr. Gano Dunn, president of the J. G. White Engineering Corporation, and Dr. K. T. Compton, president of the Massachusetts Institute of Technology. Mr. Maurice Holland has served as chairman of the Committee on Scientific Motion Pictures and Mr. Wayne M. Faunce as chairman of the Sub-committee on the Use of Cosmic Rays in the opening ceremonies. Mr. George Sakier is the designer of the central exhibit in science and education.

According to Dr. Gerald Wendt, director of science and education on the World's Fair staff, there are three major aspects of science at the fair. Of these the broadest and most important is the pervasive role of science as a social force. This is portrayed primarily in the theme exhibit within the perisphere and in the half dozen colossal exhibits sponsored by the Fair Corporation. These latter are devoted to the major areas into which the fair is divided, namely: Community Interests, Production and Distribution, Transportation, Communication, Food and Nutrition, and Medicine and Health. Each of these presents major aspects of American life, and science is inherent in each of them.

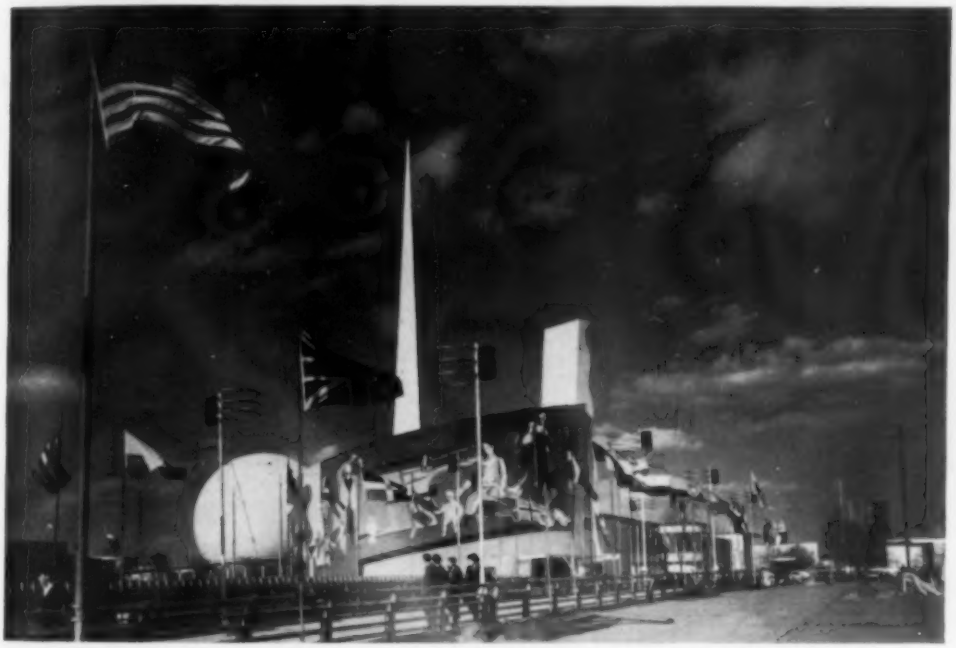
The exhibit in Community Interests may be taken as an example. It brings to a focus the area of the fair that comprises the exhibits in building materials, home furnishings, textiles and cosmetics, "the Town of To-morrow" and the exhibit of contemporary American art. At one side of the hall are shown the living conditions of 1789 with the family as a unit, both social and economic, and with all members working from dawn to dark. They live in almost complete economic independence, but with little leisure or



SYMBOLIC STRUCTURES AND THE GLASS TOWER

WHICH SOARS ABOVE THE GLASS BUILDING. THE LATTER CONTAINS EXHIBITS OF THREE MANUFACTURERS OF GLASS. ARCHITECTURALLY, THE BUILDING DEMONSTRATES MANY INTERESTING USES OF GLASS. BY NIGHT THE TOWER IS ILLUMINATED WITH BLUE LIGHT FROM INSIDE. AT THE LEFT IS A VIEW OF THE TRYLON AND PERISPHERE SEEN OVER THE ROOF OF THE METALS BUILDING

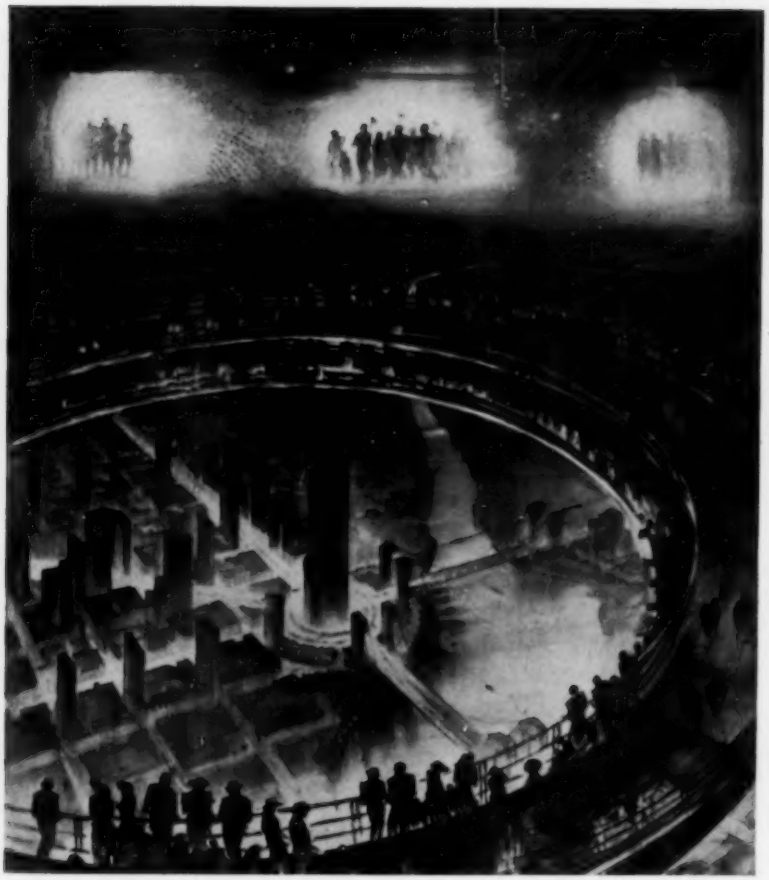
freedom for personal life. The other side contrasts the urban life of to-day, with the housewife dependent on innumerable community services and organizations, but with ample leisure and with every member of the family free from former restraints and compulsions. In the remainder of the exhibit this change is attributed to two streams of invention—one technical and the other social—whereby American life has been enriched and revolutionized. The contribution of science and its applications to this great change is stressed throughout. In a similar manner the effect of science on society through the development of communication, transportation, etc., are memorably displayed.



THE TRYLON AND PERISPHERE FROM THE "BRIDGE OF WINGS"
AT THE RIGHT IS THE HALL OF PHARMACY, AS IS INDICATED BY THE EXTREMELY MODERN MURAL BY WILLIAM DE KOONING.

The second major division of science at the fair, and probably the most impressive, is in the scores of industrial exhibits. It is not possible to select for brief special mention exhibits of any few corporations. Two features are characteristic of practically all the major industries. First, the purpose is broadly in the field of public relations rather than in the promotion of products. Second, their dependence on science and research is the dominant theme. There are numberless displays of research results and research processes. There are statues and mural paintings showing the spirit of science and the pervasiveness of research. There are lectures, motion pictures and demonstrations of scientific principles and of new facts that have resulted in important industrial and commercial developments. There are dioramas envisaging the future of farm, home and factory that may result from recent advances in science. All the sciences are thus represented, though chemistry and physics predominate in this industrial field.

There remains a third aspect in this great portrayal of science, and this is the most unique. The American Association



THEME EXHIBIT OF NEW YORK WORLD'S FAIR

ARTISTS' SKETCH OF THE INTERIOR OF THE 200-FOOT PERISPHERE AT THE THEME CENTER OF THE EXPOSITION CONTAINING AN EXHIBIT BY HENRY DREYFUSS SUMMING UP THE FAIR'S THEME, "BUILDING THE WORLD OF TOMORROW." VISITORS STANDING ON TWO PLATFORMS SUSPENDED IN SPACE AND REVOLVING IN OPPOSITE DIRECTIONS ARE SHOWN GAZING DOWN ON "DEMOCRACITY," THE PLANNED AND INTEGRATED COMMUNITY OF TO-MORROW. THE TIME IS NIGHT. THE SKY OVERHEAD IS ABLAZE WITH CONSTELLATIONS, AND IN THE DISTANCE GLEAM THE LIGHTS OF THE INDUSTRIAL SATELLITE TOWNS SPOTTED AROUND THE NUCLEAR CITY. FROM THE HEAVENS MAY BE SEEN APPEARING THREE OF THE TEN MARCHING GROUPS OF WORKERS, EACH 100 STRONG AND SINGING AS THEY MARCH, SYMBOLS OF THE INTERDEPENDENCE OF MAN AND OF THE COOPERATION BY MEANS OF WHICH SUCH A CITY AS LIES BELOW CAN BE BUILT. THE DRAWING IS BY THEODORE KAUTSKY.

for Adult Education, under the direction of Mr. Morse A. Cartwright, is sponsoring a central exhibit in which science and education are closely joined and which answers the fundamental question as to what science really is. In effect it takes for granted that science is the outstanding achievement of the human race and reveals the secret of its success. This is, of course, the "scientific method."

As the visitor enters the hall he stands in a large rotunda before a beautiful, rather abstract, model of an airplane poised in flight. Human flight is shown as a symbol of man's eternal quest for freedom and power, as an example of the sublime achievements of science and also as a challenge to education—a challenge to the human race to use its vast new powers for the welfare and happiness of the entire race. The plane is supported on a broad pillar with luminous circular pan-

els representing fourteen different sciences upon which human flight depends. These range from geology and astronomy through the more obvious elements of physical science to physiology and psychology. The moral is plain, namely, that human flight depends on vast, painstaking and pure research by thousands of workers in many lands and over many centuries. Surrounding the transparent and abstract conceptions of the fourteen sciences are scenes of industry and engineering, *i.e.*, the applied sciences.

As the visitor then passes into the main hall he faces a massive but simple exposition of the scientific method of thought. First, there are seven great panels in full color, showing observation, gathering, testing and proving of facts. They show the extent to which scientists go in securing reliable knowledge. They answer in turn these questions: What is above, beneath, beyond, within? What is matter, life, energy? Here the artist has portrayed such striking scientific scenes as the ascent into the stratosphere and the descent to the depths of the sea, the search into the remote heavens and into the interior of the atom, the analysis of matter, the mastery of energy and the mystery of life.

From these scenes paths of light lead to an enormous and luminous reservoir of facts and organized knowledge. From it three facts are drawn to exemplify scientific thought. They are the discovery of x-rays by Roentgen, the discovery of radium by the Curies and the isolation of the electron by Millikan. From these Lord Rutherford conceives the idea of the nuclear atom. His experiment in the scattering of alpha-rays by thin metallic foils is portrayed, and his necessary conclusion that the atom is indeed composed of a dense central nucleus surrounded by an electron pattern. This conclusion in turn reverts to the reservoir of science as a new fact and a new principle for the interconnection and organization of many other facts. The nuclear atom also, however, leads to industrial applications of primary importance and these in turn to radical changes in human living, as is shown in a dramatic group assembled in the living room of the American home. The exhibit thus tells in its simplest form the story of an inspired idea, based on established facts, thoroughly tested in the laboratory and resulting in a conclusion which is accepted without prejudice and without emotion to bring large consequences in science, industry and society.

"SPEED" BY JOSEPH RENIER

DOMINATING THE COURT OF COMMUNICATIONS, WHICH EXTENDS FROM THE PERISPHERE AND TRYLON TO THE COMMUNICATIONS BUILDING, IS A FIGURE OF A WOMAN ASTRIDE A WINGED HORSE. THE TITLE OF THE GROUP IS "SPEED" IN THE WORLD OF MODERN COMMUNICATIONS. BASIC MOTIF OF THE GROUP IS THE HORIZONTAL LINE WHICH IS BOTH EXPRESSIVE OF THE THEME AND INDICATIVE OF MODERN DECORATIVE SCULPTURE.

This exhibit in science is closely integrated with the related exhibit in education. As science is the best use of the human intelligence to study and improve the environment of human living, so education is, broadly speaking, the effective adjustment of the individual to his environment. As science is constantly and swiftly changing that environment, education is of necessity a life-long process and, in a democracy, is an essential duty and responsibility of citizenship.

J. M.

THE CENTENNIAL OF PHOTOGRAPHY

WHEN Shakespeare, in the early 1600's, wrote about "holding the mirror up to nature" he had no thought that he was using a phrase which would be applicable, more than two centuries later, to one of the most revolutionary scientific processes in history.

And yet that is exactly what photography did—held the mirror up to nature and captured upon that mirror the images of present events for people of the future to view.

It was just one hundred years ago on January 7, 1839, that Francois Arago, distinguished French savant, stood before the French Academy of Sciences and revealed the process of one Louis Jacques Mande Daguerre, who had succeeded in making permanent images on polished plates. Arago recommended that the Daguerre invention be purchased by the academy and be published for the free use of the entire world. On this date the science of photography had its beginning, in the broadest sense.

Some of the processes involved in photography had been familiar to men for many years. Even the camera, which is usually thought of as part and parcel of photography, had been known for centuries, in the form of the camera obscura. This was a dark chamber in which an image of outside objects was formed by means of light admitted through a small hole. Portable boxes were made with a lens at one end and a screen at the other. These cameras were regularly used by artists in their work, tracing a view directly on transparent paper. But the image was fleeting, and hundreds of people tried to discover some means of automatically and permanently recording a picture.

Since 1727 it had been known that the action of light on silver salts caused them to turn dark. This was the discovery of Johann Heinrich Schulze, a German. But there was not yet an effective combination of the image-forming camera and the image-capturing chemicals.

Many people studied the effect of light upon chemical compounds. Some tried to form images by contact—letting light shine through pictures on glass on to light-sensitive chemicals. Thomas Wedgwood, son of the famous English potter, in collaboration with Sir Humphry Davy, succeeded in making visible images in this manner, but, without a knowledge of the chemical processes of fixing the images, the pictures soon faded. Failure met their efforts to record the image formed by a camera. This was in 1800.

In 1816 Joseph Nicephore Niepce succeeded in obtaining a picture in which the highlights were dark and the shadows light. There was no idea of "positives" and "negatives." For ten years Niepce experimented, and only then succeeded in making a picture with lights and darks in their proper order. It required an exposure of twelve hours.

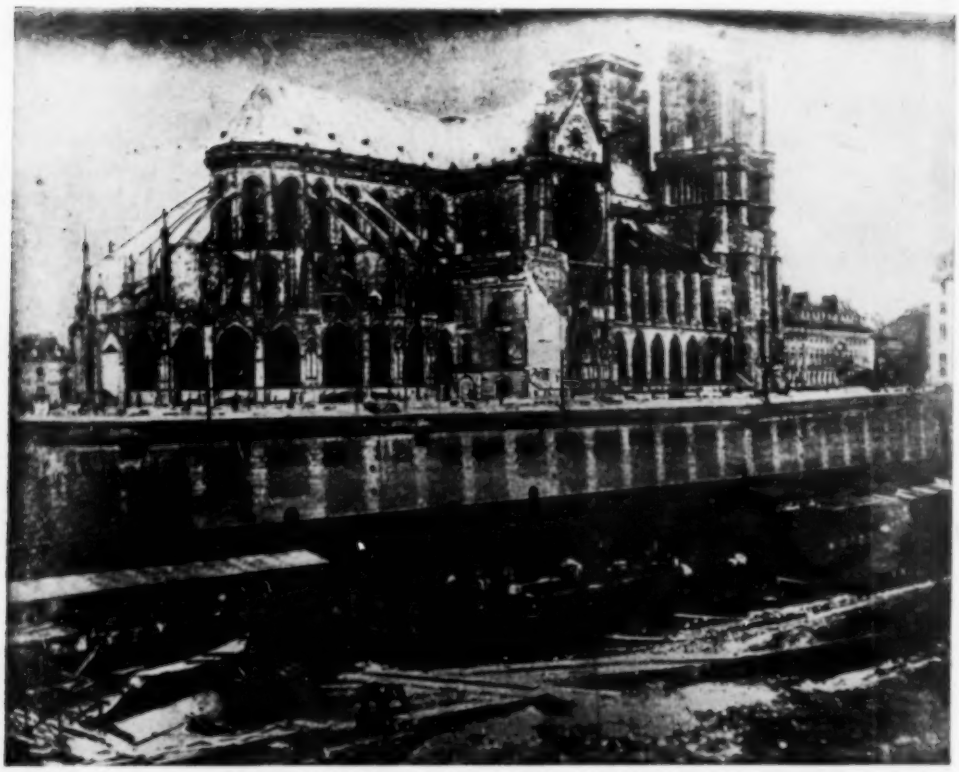
William Henry Fox Talbot, between 1833 and 1835, managed to secure tiny negative images and to fix them so that they remained upon the paper.

In 1837 Daguerre, who had collaborated with Niepce before his death, made a positive picture on a metal plate, the first Daguerreotype. He tried to interest people in his process, but nobody would give him financial support. No attention was paid to it by people who could help. Few heard of it. Most of those who did thought it was a hoax.

Arago's address before the French Academy of Sciences just a century ago changed all that. Photography was recognized by a group of unimpeachable scientists and, furthermore, the process was given to the world for the benefit of mankind.

The world wanted photography. There soon was ample proof of that. By the middle of the summer of 1839 the French Government had passed the bill giving pensions to Daguerre and the son of

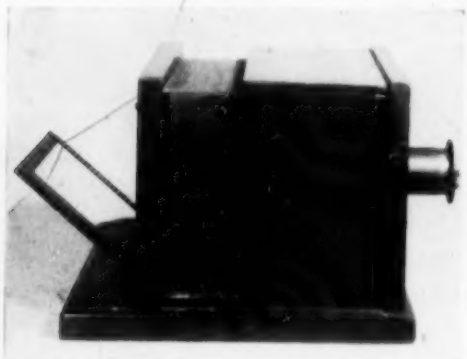
LOUIS JACQUES MANDE DAGUERRE
PHOTOGRAPH OF AN ORIGINAL DAGUERREOTYPE.



FROM AN ORIGINAL DAGUERREOTYPE—NOTRE DAME, PARIS

THIS DAGUERREOTYPE WAS PRESENTED TO THE FRANKLIN INSTITUTE BY THE PHOTOGRAPHIC SOCIETY OF PHILADELPHIA IN 1866. THIS PLATE WAS FIRST SENT BY DAGUERRE TO MR. A. GALLET OF PHILADELPHIA.

Niepce. On August nineteenth, the first public demonstration was given, with enthusiastic crowds surrounding Il Institut de France. Immediately the details of the process were published. There were twenty-six editions and translations into many languages within comparatively few weeks. Everywhere there were enthusiastic experimenters who were eager to make use of the new science of daguerreotypy.



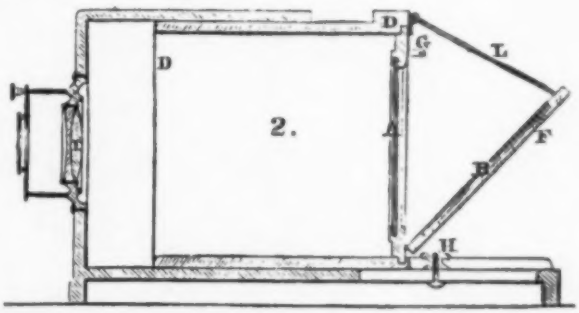
THE BISHOP CAMERA

ON EXHIBITION AT THE FRANKLIN INSTITUTE. THIS CAMERA WAS MADE IN 1839 FROM THE DESIGN PUBLISHED BY DAGUERRE.

In America rumors of the new process had been received for months preceding that date. As soon as the details were released they were sent to this country, reaching here in September. Daguerre's original paper was translated by Professor John F. Frazer, of the University of Pennsylvania. This translation, published in the November, 1839, issue of the *Journal of The Franklin Institute*, was the first publication in America.

Even prior to this publication, however, Joseph Sacton, a member of The Franklin

Observations.—**Before using the box it is necessary to clean the interior, and to turn it upside down so as to shake out of it all the small grains of iodine which may have fallen out of the capsule, taking care not to touch the iodine, which would soil the fingers. The capsule should be covered with a piece of gauze stretched upon a ring; this gauze serves to equalize the evaporation of the iodine, and at the same time to prevent the compression of the air, which results from shutting the box, from causing the particles of the iodine to fly about; some of which might rise to the plate and would make deep stains upon it.**



On this account the box should always be shut very gently, so as not to cause the rising of any dust within it, which might be charged with the vapour of iodine.

DESIGN OF CAMERA PREPARED BY DAGUERRE

AND PART OF THE TRANSLATION OF HIS ORIGINAL ARTICLE ON HIS METHOD OF MAKING PHOTOGRAPHS PUBLISHED IN THE NOVEMBER, 1839, ISSUE OF THE *Journal of the Franklin Institute.*

Institute and an employee of the United States Mint, using information received from an eye-witness of a public demonstration, succeeded in September, 1839, in making a photograph upon a piece of the silver from which the mint stamped coins.

Within a few weeks after the publication of the process, a Philadelphia chemical instrument maker, Joachim Bishop, made three daguerreotype cameras—the first to be manufactured commercially in America. One of them, still in existence, is a prized exhibit in the Photographic Section of The Franklin Institute. To mark the centenary of photography, this camera, the oldest in America, was recently used by Miss Gladys Muller to make some daguerreotypes, using the process described in Daguerre's original paper.

In the days when American enthusiasts were eagerly awaiting every new word of the process of daguerreotypy, it was frequently referred to as the art of imprisoning the sun's rays within a morocco case. From that time, a century ago, to the present day, the camera has had a growing army of experimenters. From the moment that the Daguerre process was presented to the world, for the benefit of mankind, it would seem as though all men joined in furthering the science with their greatest efforts. SYDNEY L. WRIGHT

AWARD OF THE NICHOLS MEDAL TO PROFESSOR HILDEBRAND

IN recognition of outstanding achievement in physical chemistry, Professor Joel Henry Hildebrand, of the University of California, recently received the William H. Nichols Gold Medal of the New York Section of the American Chemical

PROFESSOR JOEL H. HILDEBRAND

Society at a joint dinner of the section and the Society of Chemical Industry in New York City.

More than 400 scientists united in honoring Professor Hildebrand for "his study of the solubility of non-electrolytes." Presentation of the medal was made by John M. Weiss, chairman of the jury of award. The scientific accomplishments of the medalist, embracing more than thirty years of research on liquid and solid solutions, was described by Professor Henry Eyring, of Princeton University. Professor Herbert S. Harned, of Yale University, spoke on "Joel H. Hildebrand—The Man." Walter W. Winship, chairman of the section, presided.

In the presentation address Mr. Weiss stated:

"Professor Hildebrand is internationally known in the broad field of physical chemistry. More than that, he has been one of our few contemporary real teachers of chemistry. His public service has been of the highest order. His work in chemical warfare has contributed greatly to our national defence, both in the field and in the laboratory. His whole life has been one of service to science and the public weal."

Professor Hildebrand, a native of Camden, N. J., is 57 years of age. He received the bachelor of science and doctor of philosophy degrees from the University of Pennsylvania in 1903 and 1906, respec-

tively, and studied at the University of Berlin for a year. After teaching at the University of Pennsylvania six years, he became assistant professor at the University of California in 1913, rising to full professorship in 1918.

During the World War, Professor Hildebrand was first commissioned captain of the Ordnance Reserve Corps, then major and later lieutenant colonel in the Chemical Warfare Service. As director of the Chemical Warfare Service laboratory at Puteaux, near Paris, and as commanding officer of Hanlon Field, near Chaumont, he played an important role in organizing the American Expeditionary Force Gas Defense School and the experimental field for gas warfare research under practical conditions. For this work he received the Distinguished Service Medal.

He suggested to the U. S. Bureau of Mines the use of a mixture of helium and oxygen in place of air for divers and caisson workers to prevent the dangerous "caisson disease" or "bends." The effectiveness of this artificial atmosphere was recently demonstrated by Max Nohl, engineer, with the collaboration of Dr. Edgar End, physiologist of Marquette University, in increasing the record for deep-sea diving by 100 feet.

Professor Hildebrand is a past president of the American Physical Society, an honorary member of the Chemical Society of Edinburgh, corresponding member of the Physikalisch Medizinische Societat of Erlangen, Germany, and a member of the National Academy of Sciences. He has been councilor-at-large of the American Chemical Society. He is president of the Sierra Club and in 1936 managed the U. S. Olympic Ski Team.

Professor Hildebrand is the thirty-third chemist to receive the Nichols Medal, founded in 1902 "to stimulate original research in chemistry" by the late Dr. William H. Nichols, charter member of the American Chemical Society and leader of the chemical industry in this country.

Members of the 1939 jury of award, in addition to Mr. Weiss, were Professor A. W. Hixson, of Columbia University, Professor William C. MacTavish, of New York University, Dr. D. P. Morgan, Mr. Winship and Dr. Cornelia T. Snell, secretary of the section. A. C. S.

THE VELOCITY OF LIGHT

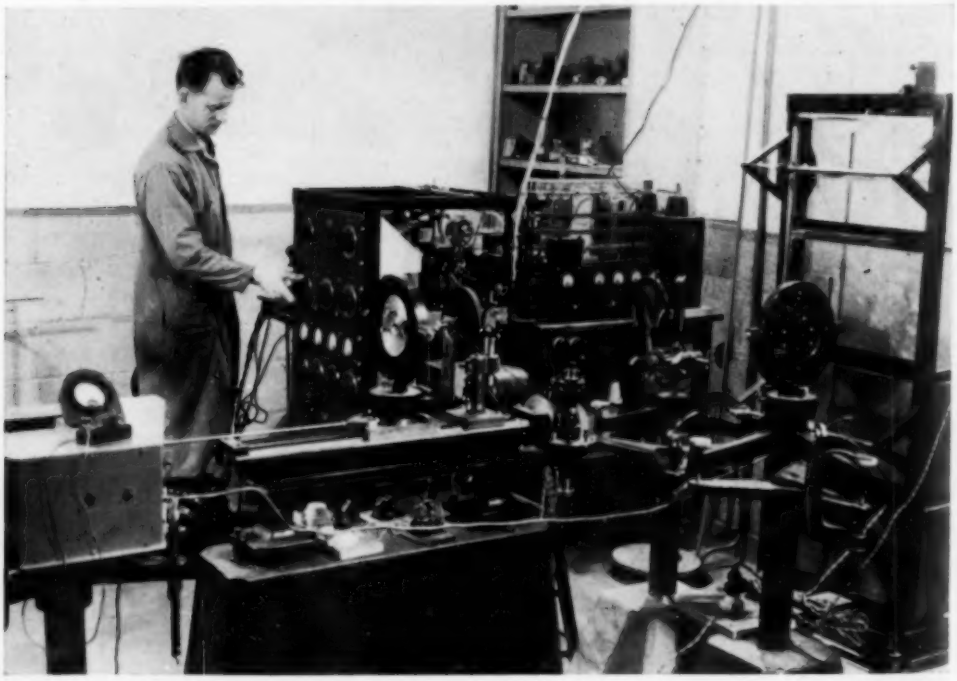
By a new method Dr. Wilmer C. Anderson, of Harvard University, has measured the velocity of light with a greater accuracy than heretofore attained. The value he obtains for this important physical quantity is 186,264 miles per second. The most precise previous measurements gave 186,271 miles per second, the two results differing by one part in 26,600. The uncertainty in the value for the velocity of light as determined by Dr. Anderson is probably less than one part in 18,000. As precise as his results are, they fall far short of the relative accuracy of several other determinations of physical quantities.

Galileo appears to have been the first to attempt to measure the velocity of light; perhaps he was the first to suspect that light is not transmitted instantaneously. A any rate, he tried to determine the velocity of light by using lantern signals between two mountains, and naturally failed. The first approximate determination of the velocity of light was by Roemer, in 1676, from observations of the times of eclipses of Jupiter's larger satellites. He obtained 192,000 miles per second. Fizeau, in 1849, was the first to measure the speed of light by laboratory methods, obtaining 195,800 miles per second. His method was modified, in 1862, by Foucault, famous for his simple proof of the rotation of the earth by swinging a pendulum. Subsequent work on the problem has been done in

this country, first by Newcomb and Michelson, later by Michelson alone, and finally, until the present experiments by Anderson, by Michelson and his co-workers Pease and Pearson. Their final value for the velocity of light, obtained after Michelson's death in 1931, was 186,271 miles per second.

Dr. Anderson obtained his results by an entirely new experimental means. He caused the intensity of a beam of light to vary periodically in brightness 19,200,000 times per second. Consequently his beam of light had relatively bright and dark portions at intervals of 51.2 feet (186,264 miles, divided by 19,200,000 reduced to feet). If two such beams were united in the same phase, the variations in brightness would be doubled; if in opposite phase, the light would be uniform. By splitting his beam of light into two parts with a half-silvered mirror and sending them over different paths of controllable lengths before reuniting them, Dr. Anderson could bring them together in the same phase or the opposite phase at will. From the difference in lengths of paths to change the beams from the same phase to opposite phase, all measured under laboratory conditions instead of using great distances, he obtained his very accurate results.

All previous methods of measuring the velocity of light required the use of rapidly moving physical parts. Fizeau employed a rotating cogwheel; Foucault, rotating mirrors; and Michelson, in his last experiments, a mirror having 32 sides. There are naturally serious difficulties in maintaining constant speeds of rotation and determining precisely what they are. The speed of light is so enormous that, using these methods, long paths of the reflected beams are necessary in order to get results of high precision. But long paths result in spreading of light and errors due to turbulence of the air. In order to maintain sharp optical images, Michelson and his collaborators, in their final experiment, sent the beam



APPARATUS USED BY DR. ANDERSON IN MEASURING THE VELOCITY OF LIGHT

of light which they used back and forth, by multiple reflections, through a steel pipe from which the air had been pumped. Few persons would undertake the serious problem of making air-tight the joints in a steel pipe a mile long and pumping the air from it. But such daring and industry are characteristic of scientists.

By modulating his beam of light Dr. Anderson avoided at one stroke the difficulties of moving physical parts and very long paths. Instead of using a mile as Michelson did even in his last experiment, and 10 miles including the repeated reflections, the whole optical path required by Dr. Anderson was only a little more than one tenth of a mile. One may inquire why his method was not used long ago. The answer is that he turned to recently developed means of modulating light, and to the photoelectric cell in determining where his reunited beams were in phase. Thus every new addition to science makes possible advances in many directions, and the further science develops the more important additions become. This aspect of the matter is somewhat similar to the old game of making as many words as possible out of a few letters. If a given letter is added to five letters it may make possible the construction of ten new words; if the same letter is added to ten letters it may make possible the construction of 100 new words.

Many persons have wondered why scientists, beginning with Roemer and continuing to Michelson, have devoted so much attention to the velocity of light. There are many reasons why the velocity of light is a physical quantity of very great scientific importance, among which are: (*a*) it is one of the several properties of light from which its nature may yet be determined; its differences in various media are a test of the corpuscular theory versus the undulatory theory of light; it is taken as an absolute constant and the maximum possible velocity in the theory

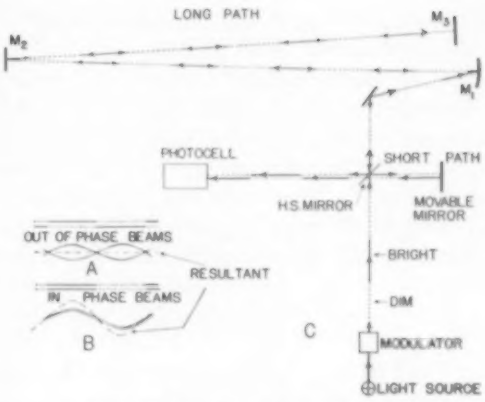
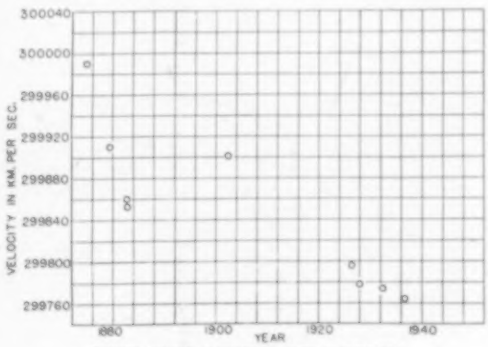


DIAGRAM OF APPARATUS

of relativity, a theory which was initially developed to explain Michelson's failure to find the expected effects on the velocity of light of the earth's (and observer's) motion through the assumed ether.

The question now arises whether the velocity of light, as determined by measurements, will be found constant. If it should not be found constant, it will apparently be necessary to revise the relativity assumption that it is a fundamental constant of the universe. Of course, since a velocity is a distance directed by a time, an observed variation in the velocity of light could be interpreted as a variation in the length used, or in the measurement of time intervals, or in both. Each of these assumptions would raise other questions and make difficult the development



THE VELOCITY OF LIGHT
VALUES OBTAINED AT DIFFERENT DATES.

of consistent and satisfactory theories of all the related phenomena.

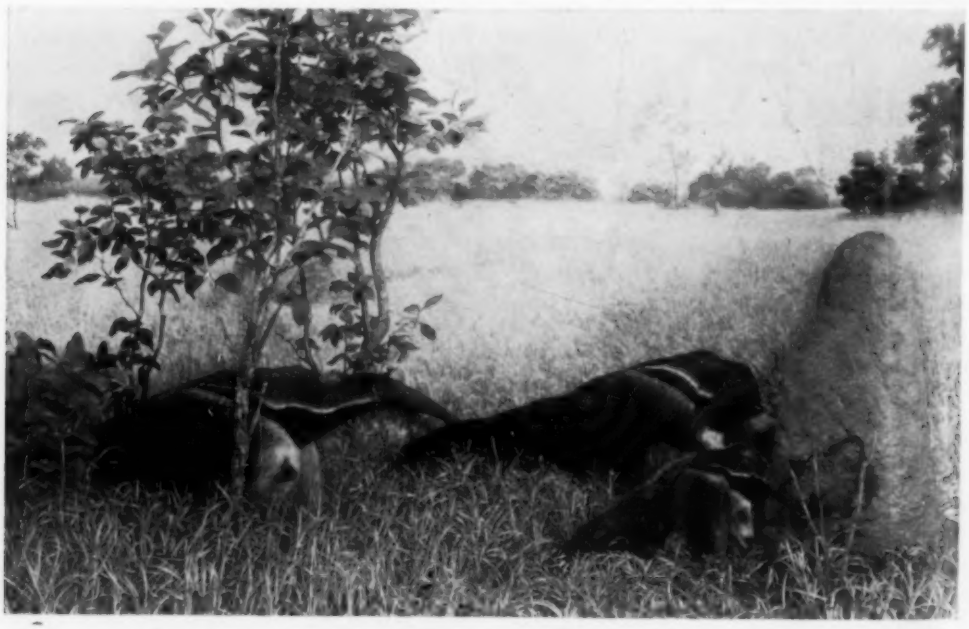
All this illustrates Poincaré's thesis that every set of phenomena can be interpreted consistently in various ways, in fact, in infinitely many ways. It is our privilege to choose among the possible interpretations the ones that appear to us most satisfactory, whatever may be the reasons for our choice. If scientists would remember that various equally consistent interpretations of every set of observational data can be made, they would be much less dogmatic than they often are, and their beliefs in a possible ultimate finality of scientific theories would vanish.

F. R. MOULTON

THE GREAT ANTEATER GROUP AT THE FIELD MUSEUM

ONE of the additions to the Hall of American Mammal Habitat groups in the Field Museum of Natural History is an exhibit of the great anteater. This animal, which ranges from southern Mexico to southern Brazil, is one of the queerest of the many queer beasts inhabiting the American tropics. It is peculiar in appearance, in structure and in habits. One of its names is ant bear, perhaps on account of its large size and shaggy coat, but it is not even remotely related to bears. It belongs to that rather anomalous group of mammals called edentates, of which the known extinct species are much more numerous than those now living. It is one of three principal kinds of anteaters in South America and Central America, the other two being the Tamandua and the silky anteater, both smaller and more arboreal in habits.

The bizarre appearance of the great anteater is largely due to its very long and very narrow head. This is so highly specialized that a description of it seems to call for hyperbole, and one is reminded



THE GREAT ANTEATER GROUP

of Mark Twain's famous characterization of the Platte River, in which he said that it was "a mile wide and an inch deep." The anteater's head is actually six times as long as it is wide. In other words, it is longer than that of a very large grizzly bear and scarcely wider than that of a jack-rabbit. The mouth is reduced to very small size, only serving as an opening through which to protrude its long, extensile tongue and draw in its insect food. That such a large animal should be wholly sustained on a diet of ants and termites seems incredible, but this is the case. Although this must be regarded as strong testimony to the abundance of these insects in the countries south of us, it is still stronger as to the efficiency of nature's machine for capturing them in large quantities. The great anteater has sometimes been kept alive successfully in zoological gardens, but it is an expensive pet, for its board bill runs to high figures. To supply it with all the insects it needs reaches a cost rivaling that of the tons of hay for the elephant.

Teeth are unnecessary for an anteater, and they have been entirely eliminated, but the animals are provided with unusually large salivary glands which supply a viscid secretion to assist the effectiveness of the tongue. The long, heavy claws of the front feet are used mainly for tearing open the ant and termite nests, but can be used very effectively when necessary in defense. For this reason the anteater is held in very great respect by local hunters and also by such predaceous animals as the jaguar and the puma, which are usually inclined to give it a wide berth. Many a good hunting hound has been literally disemboweled by a powerful sweep of these claws.

The museum's group was obtained by Colin C. Sanborn during the Marshall Field-South American expedition of 1926. The animals are shown in the light forest or semi-savanna of southwestern Brazil, where the physical conditions are those they prefer. They may also occur about the edges of heavy, humid forests but do not penetrate far into them. The taxidermy is by Julius Friesser and the painted background by Charles A. Corwin.

WILFRED H. OSGOOD

COMPOSITION OF GASEOUS NEBULAE

SIR WILLIAM HERSCHEL, 150 years ago, thought that the nebulae are systems of stars so far away that their members could not be seen separately through the telescopes then in existence. But he looked forward hopefully to a time when better telescopes would resolve them into individual stars. Herschel's ideas were proved to be erroneous about a century later when it was proved with the spectroscope that the light received from the nebulae, at least in many cases, is radiated by great masses of gas. The spectral lines showed that the radiating elements are such light gases as hydrogen, helium, nitrogen and oxygen.

Naturally astronomers speculated on the origin of the gaseous nebulae and their future evolution. The idea prevailed widely that they are world-stuff in an early stage of evolution, and that in the course of enormous intervals of time they will concentrate into stars. It was supposed that in some unknown way such heavier elements (iron, nickel, copper, etc.) as are found in the sun would evolve.

At the meeting of the National Academy of Sciences held in Washington on April 24 and 25, Dr. I. S. Bowen, of the California Institute of Technology, announced that the gaseous nebulae contain the heavier metallic elements found in the sun and about in the same proportions. These elements were now found earlier, because under the conditions existing in the gaseous nebulae their spectral lines

(the wave-length which they radiate) are predominantly different from those in the sun.

Of what especial interest is this discovery of Dr. Bowen? It will bear directly upon every theory of the evolution of matter in the immense intervals of the cosmic processes. Perhaps the theory that nebulae are world-stuff in an early stage of evolution will have to be abandoned. Possibly the stars and the nebulae are only different phases in an evolutionary cycle transcending anything heretofore contemplated. F. R. M.

A NEW EXPLANATION OF SUBMARINE CANYONS

Dr. Douglas Johnson, of Columbia University, presented before the April meeting of the National Academy of Sciences a new hypothesis respecting the origin of the amazing submarine canyons that have been found during recent years off both the Atlantic and Pacific coasts of this country and in other parts of the world. These canyons are deep, often with very steep walls, and resemble canyons produced by swiftly flowing, deep-cutting rivers. Indeed, in some cases they are comparable to the Grand Canyon of the Colorado.

A natural explanation of the submarine canyons is that they were formed when the coast lines were higher than at present, and in some cases they certainly have been. But the changes in level required by this theory are not easily reconcilable with other known facts. Other suggested explanations encounter equal difficulties.

Dr. Johnson recalls the fact that water expelled under artesian pressure in springs on land often produces marked canyons in relatively short intervals of time. He suggests for consideration the hypothesis that submarine canyons have been produced similarly by water forced up by hydrostatic pressure through consolidating sediments that have been deposited off coast lines. Certainly such pressures and eruptions might take place. The problem is to determine whether they would produce canyons having the characteristics of those that are found in the continental shelves off many coast lines. F. R. M.

MENTAL BREAKDOWNS IN THE AFRICAN VELD

New evidence for a similarity between the minds of men in darkest Africa and residents in the capital city of the United States was seen when a film taken in a mental hospital of South Africa was shown before an audience of anthropologists in Washington, D. C.

Mental breakdown occurs in the veld as it does in the modern metropolis. And the mentally ill are considered "queer" by their neighbors in primitive society, just as they are in civilization.

Bantu patients coming to the mental hospital in Africa bear evidence of never having taken part in the rites introducing them to mankind. Many have never been taken into the tribes as adults, presumably because it was recognized that they were not acceptable.

Neither had they taken part in the usual social customs of the tribe. Among the Bantus, boys and girls customarily take part in a sort of courtship custom not unlike the old New England custom of "bundling." But Dr. J. B. F. Laubscher, the psychiatrist who filmed these African mental patients, found that many of them had never been able to attain such terms of intimacy with any girl in the tribe.

Those who consider mental breakdown to be the result of the excessive strains of modern civilized life may find food for thought in the faces of the Bantu actors in Dr. Laubscher's real-life film drama. The patients in this far-away African hospital can be matched, case for case, in St. Elizabeths Hospital at Washington, D. C. The similarity was pointed out by Dr. Winfred Overholser.

Majorie Van de Water
Science Service